
G.S. TERENCE CAVANAGH
VITA
SINE
LITTERIS
MORS
EST

LECTURES

ON

THE GENERAL STRUCTURE

OF THE

HUMAN BODY,

AND ON

THE ANATOMY AND FUNCTIONS OF THE

SKIN;

DELIVERED BEFORE

The Royal College of Surgeons

IN LONDON,

IN THE COURSES FOR 1823.

By THOMAS CHEVALIER, F.R.S.

F.S.A. F.L.S. & F.H.S.

SURGEON EXTRAORDINARY TO THE KING, AND
PROFESSOR OF ANATOMY AND SURGERY TO THE COLLEGE.

LONDON:

PRINTED FOR

LONGMAN, HURST, REES, ORME, BROWN, AND GREEN,

PATERNOSTER-ROW.

1823.

TO

MATTHEW BAILLIE, M.D. F.R.S.,

PHYSICIAN EXTRAORDINARY TO THE KING,

&c. &c. &c.

MY DEAR SIR,

When I found an expectation was entertained that I should publish these Lectures, several considerations immediately concurred in determining me to take the liberty of dedicating them to you.

They were delivered before The Royal College of Surgeons; for which establishment you so liberally joined with Sir Everard Home, to found The Hunterian Oration.

From your lucid and accurate Lectures and Demonstrations, my thirst for anatomical knowledge, more than thirty years since, received the greater part of its earliest gratification; and to your most kind and unwearied professional care and discernment, I have been repeatedly and deeply indebted.

That you may long continue to enjoy the high reputation which you have attained by a peculiarly distinguished and honourable course in life, is the sincere wish of,

Dear Sir,

Your much obliged

And obedient Servant,

THOMAS CHEVALIER.

ADVERTISEMENT.

After these Lectures were printed, and the publication of them awaited only the completion of the figures, the eminent Physician to whom they are dedicated, was removed from this life. The Author has not, however, cancelled the dedication; wishing it to remain as a mark of the high estimation in which he always held the character and conduct of that excellent person.

ERRATA.

Page 7.	line 5.	*for* Arvis, *read* Arris.
65.	6.	*for* prostæ, *read* præsto.
99.	1.	*for* all among, *read* among all.
106.	1.	*for* surface, *read* surfaces; *and for* its *read* it.
108.	10.	*for* sibaceous, *read* sebaceous.
112.	15.	*for* granulation, *read* granulations.
162.	12.	*for* crisis, *read* crasis.
229.	10.	*for* defect, *read* defeat.

LECTURE I.

March 18. 1823.

Mr. President, and Gentlemen;

Before I proceed to address you on those subjects, to which it is my purpose to invite your attention in the present course of lectures, my duty and my feelings call upon me to pay a tribute of respect to the memory of that gentleman, whose sudden and lamented decease produced a vacancy in the office, in which I have now the honour to appear before you. The accuracy of the late Professor Wilson, as a demonstrator and teacher of anatomy, was displayed, for a long course of years, in one of the most celebrated and most useful schools in this metropolis, and will live in the remembrance of many who hear me. The three courses of lectures which he delivered from this

chair, and which are happily preserved, by publication, for the benefit of those who had not the opportunity to attend them, for propriety of choice, for the importance of their subjects, and the judicious arrangement of their valuable materials, secured our united approbation and praise. Nor must I omit to notice that urbanity of manners, which always gave us satisfaction and pleasure, in seeing him take his place, when he joined us in attention to those important duties, which devolve upon the members of the council of this College. It is now my task to endeavour to supply his place in this Theatre. But I must first of all express to you, Mr. President, and to the rest of my honourable colleagues in the council, my grateful acknowledgments for that favourable opinion which has induced them to call me to a situation, hitherto occupied by professors, to whose scientific discourses I have so often listened with pleasure and instruction.

Talent, however, is variously distributed, among those who travel in the same path

of science. One may gather that which another has overlooked, or which had not previously sprung up into notice. Nor does this truth necessarily imply a deficiency, or an absolute predominance, either of ability or of industry, in the one party or the other. Spectators of the same object, being themselves in different positions, may notice facts and features, which no one of them singly has yet had an opportunity to survey ; but which the mutual communication of their observations may enable them all advantageously to view, to recognize, and to combine. Moreover, the eye of the mind, as well as that of the body, too often passes unheedingly over objects and circumstances within its ken, but which do not, at first, attract or fix its attention ; and that attention may be afterward directed to them by casual events, or by inferior observers. Nor is it a minor trait of character which Livy has preserved of the genius and character of Scipio, in his famous speech to Fabius and the Roman senate, before his departure for Africa, *Id est viri et ducis oblata* CASU, *flectere ad consilium.*

But the *consilium*, the object in view, must have a distinct and certain pre-existence in the mind. Our notices may then be arranged. All our observations will naturally be combined by those who succeed us; with corrections, and additional facts, and illustrations; and by the whole, the public will be benefited, and science advanced. Nor are lesser efforts always to be despised because they are not greater; nor the greatest we can witness to be considered as absolutely perfect. The temple of knowledge is to be reared by the exertions of ordinary, as well as of extraordinary hands: nor could its fabric have possessed the comparative altitude it has already attained, without the concurrent assistance of both. Both must be governed by the same inviolable principles, to which, whosoever adheres, may render acceptable service; and from which, whosoever departs, must retrace his steps.

Such, Gentlemen, are the considerations which have encouraged me to undertake the honourable, but responsible office, of

one of your Professors of Anatomy and Surgery. — Here, I am well aware, there is no partiality that will applaud error. Here, no honest effort will lack its meed of approbation. I feel an equal reliance upon the candour, and the judgment, of those before whom I am to speak. I have lived too long not to be acquainted with my own weakness and fallibility; — too long also not to have discovered, that science, if not still in its infancy, has not yet attained adolescence; and stands in need of the united exertions of all who love it, to nurture, to strengthen, and to mature it. And I contemplate, with an undescribable satisfaction, those rising abilities, of which such happy earnests have already been given among us; and which, in their progress, will adorn and fertilize our College, and the medical schools of this metropolis, with a succession of able, laborious, learned, scientific, and useful teachers.

The foundation of this College by our late most excellent Sovereign, the donation to it by Parliament of Mr. Hunter's incomparable museum, and the consequent establishment of lectures to be annually delivered in this Theatre, have combined to form an important epoch in the History of Surgery in England, by more intimately connecting the pursuit of that important branch of human knowledge with general philosophy, and natural history; and furnishing both means, and inducements, to labour for its cultivation and improvement, as a science. In this field of exertion Mr. Hunter conspicuously led the way; and it was a wise provision of the legislature, when they purchased the collection of preparations which he had formed, that in order to prevent its decay, it should be preserved by this College, exposed to view, and its contents publicly explained by lectures, and proper attendants, to perpetuate the good effects his talents and industry had produced, both on the state of surgical science, and of those subjects which he had brought to bear upon it. In the late

Corporation of Surgeons provision had been formerly made for only six lectures, which were chiefly confined to the bones and muscles. These were founded partly by Mr. Edward Arvis in 1653, and partly by Mr. John Gale in 1698; but they had become merely nominal discourses, that have been entirely superseded in utility and attraction by the private schools, in which these parts are explained more fully, and in connection with other branches of anatomy. They were therefore neglected, and frequently omitted. The Council and Professors of this College have since thought it justifiable, to abide rather by the spirit than by the letter of the institution, and to consider rather what the benevolent founders would have done *now*, than what they contemplated at a period when there were few means only, and those very limited and imperfect, of attaining any portion of anatomical knowledge. Their six lectures are consequently understood at present to embrace any subjects in human anatomy or physiology, which can tend to illustrate or advance the principles and practice of Sur-

gery. To these lectures nine on surgery are added, as a part of twenty-four which we are required to give by the tenure of that trust, on which the legislature and government of the country made us the noble present of Mr. Hunter's collection. The remaining fifteen, as you are well aware, being devoted to comparative anatomy.

The lectures on surgery can neither be calculated, nor intended, to interfere with those elementary instructions which are delivered to students in the several schools of this metropolis; much less to supersede them. Their object is, as I have just intimated, to bring forth private stores, for the general benefit, by exhibiting the various modes of considering subjects of general professional importance, which men of various habits of thinking, and having different fields of observation, will necessarily adopt. It has been one of the greatest and most unfortunate and embarrassing disadvantages, attending medical and chirurgical science, that its different practitioners and

professors have often met with a number of successful cases in quick succession, of an individual character ; or of the utility of a particular remedy, in their own personal, and perhaps accidental experience, that has led them to form hasty and illogical conclusions, not referable sufficiently to sound and definite principles, and therefore which have not been sustained by the experience of others, and have also been ultimately disappointed by their own. Medical history abounds with examples of this fact, which has often given too empirical a character to the practice of many highly respectable men ; and furnishes a caution for students and young practitioners, against too great an eagerness to grasp at publicity, by assuming that a method of treatment must always succeed, because they have seen consecutive instances of its doing so. The younger members of the profession have now the advantage of an opportunity of re-considering the subjects they have learned, with some additional illustrations ; while those members of the College who have finished their initiatory studies, and

whose engagements unavoidably prevent them from resorting to the situations in which they had before pursued them, will be enabled to keep up a connected view of that system of general principles, which, in the hurry of life, are apt to fade, in a greater or less degree, from their former impressions on the mind. They will also be put in possession of those additions, in their due order of arrangement, which are from time to time made, to the sum of our professional knowledge. More speedy and general circulation will thus be given to extended views in the *Science*, and to improved methods in the *Art* of surgery. We shall become more useful to, and better acquainted with, each other. Little jealousies will be abolished: we shall be more serviceable to those who confide themselves to our care; better instructors of the rising generation, and contribute more fully and more effectually to the general welfare of mankind.

Of comparative anatomy, the field is so vast, and as yet so imperfectly surveyed,

that the institution of lectures expressly on that subject was peculiarly needful. A considerable part of our anatomical nomenclature has been formed from the examination of other animals; and to experiments which could alone be made on them, we are indebted for our first knowledge of some of the most important physiological facts. Nevertheless, this valuable branch of science had been in reality, of late, but little cultivated, and but little employed. The attention of anatomists had been chiefly directed to those animals which most resemble the human subject, and to these with only imperfect means of investigation. An extended and general enquiry into the internal structures and functions of animated beings in general had been, in latter times, considered rather as curious than as useful or necessary. Mr. Hunter, however, clearly perceived its value, and referred it to its proper end, namely, the elucidation of the laws and operations of the human body. For this purpose he availed himself, with diligence, of all the known methods of examination, and formed the plan, and

sought out the materials, of that rich collection, with which we are entrusted, and which we are constantly labouring to increase, to explain, and, as far as possible, to perfect. In no place, therefore, could discourses on this subject be delivered with more propriety than in this, where the stores he acquired are deposited and arranged, so as to form a kind of demonstrative text-book to this interesting study. Highly worthy is it also of this favoured country, enabled as she is by her unequalled commercial and political relations, to furnish the means for its promotion, to hold out a conspicuous and public example, of pursuing those enquiries by which Comparative Anatomy may be advanced, and of prepossessing her native surgeons as they grow up, and before they are dispersed through her extensive empire, with just ideas of its value and interest, and directing their attention to its illustration. —*Ignoti nulla cupido.* If it were not brought before us in regular course, it would be in great danger of falling again into neglect. But being now brought forward into general notice from year to year, and curiosity and

laudable ambition being not only excited, but also directed, as it has been, and is, in this Theatre, the number of contributors to our accumulation of specimens and facts will naturally increase, and new information, convertible both to present and to future use, may be expected constantly to flow in. The lectures of Sir Everard Home, Sir Astley Cooper, Mr. Lawrence, and of Mr. Brodie, need no commendation from me. They have kindled feelings in their hearers which are now in a course of beneficial operation, and must produce results that will reflect lasting honour on the examples which have been set by those distinguished professors, and be productive of great good to those who have had the advantage of attending their interesting and scientific addresses.

I congratulate, therefore, the different ranks of our profession, and the public at large, on the foundation and progress of an establishment, having such valuable objects in view; and I may repeat, that when I advert to the talents of many of our mem-

bers which are now in their bloom, and those of others, which are coming forth with the most hopeful promise, I cannot but feel a most gratifying anticipation, that this Chair will continue to be filled by a succession of professors, who will do honour to themselves and to the College; and that from hence will emanate those rays, both of natural and chirurgical knowledge, which shall extend their beneficial influence to every part of the habitable globe; shall contribute to dignify the pursuits, to promote the harmony, and to lessen the miseries of mankind; and display more and more, to admiring myriads of our race, the inexhaustible power, and unfathomable perfections, of our omnipotent Creator.

But our chief concern, at present, is with Surgery, and with anatomy, physiology, and pathology, as constituting the foundation on which it rests, and the object of which is to relieve and to cure the injuries, disorders, and diseases of mankind. Those, however, which affect animals subservient to the necessities or conveniences of man, and

especially such as possess organs similar to his, in their structure or functions, should not be neglected, or left out of our contemplation. And we have the pleasure of numbering among the distinguished members of this College, a gentleman *, who, after having passed through a full and honourable course of professional education, did not disdain to devote himself to this branch of knowledge; and has attained in it a rank of scientific eminence not before enjoyed by any individual in this country. He has thus been enabled to render those services to society, that should place the study and treatment of the diseases of subordinate animals on just and philosophical principles; have extended an acquaintance with those principles, and the practice deducible from them; and has laid the foundation of much future benefit and comfort to that large portion of society, whose interests are materially, and often essentially involved, in the health and soundness of the animals that labour for

* Professor Coleman.

them, and contribute to their sustenance, or to their defence.

There is also an anatomy, a physiology, a pathology, and even a surgery, of Vegetables. Are these altogether unworthy of our attention? Mr. Hunter did not think them so. His acute and philosophic mind was habituated to glance on every department of animated nature that came under his notice, so far as he could discover it bore any relation to the œconomy of the human body, or could illustrate its morbid conditions, or its restorative processes. I need not here cite proofs of this. They are contained in his writings, and in this museum; and show that his amusements took their character from the prevailing turn of his mind for investigation; and bore a stamp of his scientific objects, and of the ingenuity, ability, penetration, and diligence with which he pursued them.

Yet, after all, whatever things may suggest themselves to our minds, as necessarily implicated in the course of our studies, or

as calculated to throw additional light upon them, we must at last form an estimate of them by their relation to the human body; its structure, its functions, its injuries, its diseases, its reparations, and its dissolution. And let me not be thought irrelevant, or disrespectful, in observing, that it is necessary that the student of surgery should take care that he be not drawn too far aside by any collateral objects, on account of the separate interest they may possess, or the amusement they may afford, from the main purpose to which he is to refer them, — the restoration of health and soundness to his patients. It was Mr. Hunter's care, perhaps far beyond that of any other surgeon that ever existed, to make all his varied pursuits concenter in this point; and it is much owing to the influence of his example, directly or indirectly, that so much benefit has been since derived from the contemplation of other animated beings, and from experiments made upon them, and applied to the physiology and pathology of man.

What then is man — this being, who is the subject of our Surgery, and the ultimate object of all our investigations? Of what is he composed? How is he constructed? What is he to himself? How is he related to other beings around him, animate or inanimate, and how are they related to him? What are the natures, and what are the influences, of his passions and emotions? What are his physical, his intellectual, and his moral faculties? What are the destinations of his existence on this globe? How is he capacitated to fulfil them? How is he likely to fail? What are his resources when struggling with impediments from affliction? And by the agencies of what causes is that primæval sentence at last infrustrably fulfilled, — "*Dust thou art, and to dust shalt thou return?*" — Questions these which embrace a field of philosophical enquiry, vast in its extent, minute in its details, and infinite in its importance.

Man is a material, a living, a rational, a mortal, an immortal, and an accountable

being. Simple elements, apparently simple at least, so far as our confined powers of investigation extend, compose a fabric of wonderful complexity, with the minutest adjustment of all its parts, and of all the particles of every part. In this, however, he differs but little, in respect to perfection, from the living bodies which surround him. All nature teems with equal proofs of wisdom in design, and of perfection in the adaptation of means to ends. In this view, therefore, he is a machine, subject, like other machines, to the same mechanical principles, by which all machines must be controuled. Like them, by certain laws he stands, he moves, he totters, or he falls; the parts of which he is made up are kept together or dissevered; are dislocated, distorted, or replaced.

What, therefore, is the power, that, since the creation, and under obedience to the laws then enacted, generates, increases, adjusts, completes, regulates, and repairs this machine? What is this power, which possesses that controuling influence over ordi-

nary affinities; which preserves and directs all its parts to their destined uses; implants in them an innate repugnance to such things as may injure or impede them; makes it accept of those which may assist, sustain, and employ them; makes it seek for those which may promote their restoration when disordered, and makes it shrink from those by which their integrity, their co-existence, or co-efficiency, may be endangered or destroyed?

To assert that the mere accretion and arrangement of the materials of which living bodies are composed, is competent to these objects, appears to me contradictory to the soundest principles of reason and philosophy. It is making the very same thing to be its own cause, and its own effect. Often as the words of Mr. Hunter on this subject have been quoted, I cannot help reciting them. I am not now professing, Gentlemen, to bring forth new ideas respecting it; I make these remarks, as forming what I conceive to be a suitable introduction and preface, which may serve

to connect and embody the different parts of the plan I have drawn out for myself with greater consistency and method; to make it clearly and unequivocally understood what are my sentiments on these subjects, (established in my mind by no cursory survey, but by the deliberate, and, I trust, impartial and conscientious examinations of many years,) before I proceed to the minuter details, in the consideration of which they are more or less implicated; and thus to save my audience and myself from the trouble of suspecting, or giving a controversial character to any of the subsequent Lectures which I may have the honour to address to you.

"Organization and life," observes Mr. Hunter, "do not depend in the least on each other. Organization may arise out of living parts, and produce action; but life can never rise out of, or depend on organization. An organ is a peculiar conformation of matter, let that matter be what it may, to answer some purpose, the operation of which is mechanical. But mere organ-

ization can do nothing, even in mechanics; it must still have something corresponding to a living principle, namely, some power."

Organization, therefore, must be considered as the mere mechanism, by which the living principle dominates over its allotted portion of material substance, adapting it to certain definite purposes, according to the destiny of the living being in the system of nature. "Our ideas of life," Mr. Hunter has justly and beautifully observed, "had been so much connected with organic bodies, and principally those endowed with visible action, that it required a new bend to men's minds to make them conceive that these circumstances were not inseparable." Yet all animated nature teems with proofs of the fact.

The power peculiar to life is evidenced by four principal features. The first is that of self-preservation, called by Dr. George Fordyce, "*the attraction of life*"—I would rather call it the *cohesion* of life; by which the matter of which this mysterious prin-

ciple takes possession, is preserved, by its dominion over it, from decomposition. A second is that of attraction, literally so called, by which it takes and combines with the living and self-preserving substance, whatever tends to further and support its purposes; and in this indeed consists the first *overt act* of the series of acts by which we recognize it, and it is constantly displayed, during its continuance, in nutrition. And I presume it was this consideration that induced Mr. Hunter to place on the first shelf of his series of preparations, for illustrating the œconomy of life, the bulb of a common hyacinth, which had been placed on a root-glass at the proper season, and had just begun to shoot down its roots, and show the green commencement of its vernal growth. To this power is necessarily superadded the power of rejecting that which is incompatible with its purposes, or which, by use, or by injury, or by disease, has become so. But the fourth and most remarkable property, and to which all the rest are subservient and supplementary, is that which has been called susceptibility, excitability,

or irritability; for although this latter term has been chiefly applied to the muscular structure, and therefore almost synonymized with contractility, the import of the word may be legitimately extended farther, and applied to the capability which living parts possess of altering their own condition, either from causes arising in the mechanism of which they form a part, or from causes which act upon them from without. Whether, therefore, we look at the composition, or the adaptation of the matter, the regularity of the form, or the final causes of them all, we must never lose sight of this active power, to which the organization of the material substance is, as we observed, merely a mechanical instrument. Indeed we shall always be exposed to serious mistake, if our eyes are not constantly intent on both these objects. To confine our attention to the matter, and to disregard the power by which it is actuated, must be an error of awful amount. For how wonderfully is this power displayed "in the operations constantly going on in every organized body, (I here borrow the elegant language of the

learned President of the Linnean Society*) from our own elaborate frame to the humblest moss or fungus. Those different fluids, so fine and transparent, separated from each other by membranes as fine, which compose the eye, all retain their proper situations (though each fluid individually, is perpetually removed and renewed) for sixty, eighty, or a hundred years, or more, while life remains. So do the infinitely small vessels of an almost invisible insect, the fine and pellucid tubes of a plant, all hold their destined fluids, conveying or changing them according to fixed laws, but never permitting them to run into confusion, so long as the vital principle animates their various forms. But no sooner does death happen, than without any alteration of structure, any apparent change in their material configuration, all is reversed. The eye loses its form and brightness; its membranes let go their contents, which mix in confusion, and thenceforth yield to the laws of chemistry alone. Just so it happens,

* Introduction to Botany, p. 6.

sooner or later, to the other parts of the animal as well as vegetable frame. Chemical changes, putrefaction and destruction, immediately follow the total privation of life, the importance of which becomes instantly evident, when it is no more." And well does this able writer conclude these remarks by observing, "that if the human understanding can, in any case, flatter itself with obtaining, in the natural world, a glimpse of the immediate agency of the Deity, it is in the contemplation of this vital principle, which seems independent of material organization, and an impulse of his own divine energy." Yet, after all, to look at this power, as if it were magical, without a dutiful and scrutinizing attention to the composition and arrangement of the material under its government, would lead us into all the absurdities of empiricism. These two fields, then, display a long and arduous task before us; in which all indeed cannot equally engage, but in which some of us must labour and toil for the benefit of the rest, for our own reputation, for the honour of our profession, and

for the security of those objects by which we are all morally connected, — the alleviation of human suffering, and the general good of mankind.

But as man is mortal, and as mortality, and those things which tend to certify, to accelerate, and to prevent, or rather to postpone it, give to our profession its importance, these form our greatest concern. Some injuries, by their mechanical effects, spoil or impair the members of which the body consists, and disable man, for a longer or a shorter period, from fulfilling the relative purposes of his existence here. Some diseases sudden in their occurrence, others slow in their operation, at length arrest his projects, annul his energies, or reduce him to an inanimate mass. Of these, who shall count the number? Who can trace the variety? Who can resist the effects? Yet such is the duty, such the labour, such the pleasure, and, alas! too often such the disappointment, of our most anxious and strenuous efforts.

Yet these efforts would lose their importance, were the life of man merely like that of a plant, or of a beast, and simply intended for temporary display, and for destruction, — had he not powers, did he not possess passions, were he not susceptible of emotions, capable of projects, and answerable for purposes, different from, and infinitely superior to, all other living beings, which cover the surface of the earth. To him has been allotted, not merely a capacity to be trained, or to train, for subservient usage; but also the power of directing that capacity to ages beyond him. On him has been bestowed the power of accumulating the knowledge of others around him, and of those who have lived before him, and of storing up the whole, with such additions as he can collect, for the benefit of those who are to succeed him. His passions, his emotions, his wishes, his designs, and his reflections, and the effects of them all, are subjects of our serious and necessary contemplation; for he is accountable, and he is immortal. No apology can be necessary for saying this here. —

Surgeons indeed are chiefly concerned with the body; but it is with a body under the influence of mind. For as it is not in the mere mechanism of the human body, so neither is it in the possession of the principle of life, that it surpasses other living structures; many of which are seen to be capable of retaining that principle, or rather of being retained by it, and of preserving the form which they had attained under its influence, when they become disunited from it, for a longer period than man, and under circumstances which to his frame would be speedily and inevitably destructive. It is therefore in the nobler purposes for which man is formed, and the construction and arrangement of his organs to answer and to conform to these nobler purposes, that he surpasses them all. In many sensibilities less acute; in locomotive powers greatly inferior; in muscular energies far less powerful and active; and even in durability of material composition exposed to sudden or slow destruction, from causes within him and without him, more than some minute, and apparently insignificant

animals; and inferior in stature to many, he is still the visible head of them all. Fitted for his uses, formed for the successive objects of his observation, subjected to his dominion, excitements to his industry, warnings to his caution, incentives to his hopes, or animating evidences of his dignity and his destiny, all of them call him master, and feel exposed to his authority, his stratagem, or his force, whether they lurk in concealment, or gnash in rage.

Yet, how superior soever in condition, however superlative in beauty; however dignified in form, however noble in the ultimate purposes of his creation, however he may soar, "in all the magnanimity of thought,"

———— "Death's subtle seed within,
Sly, treacherous miner, working in the dark,
Smiles on his well-concerted schemes, and beckons
The worm to riot on a rose so red."

Nascentes morimur, finisque ab origine pendet.
MANIL. Astr. iv. 16.

The young disease, which must subdue at length,
Grows with our growth, and strengthens with our strength.

That injuries or diseases, mechanically affecting and deranging those organs which are necessary to carry on the functions of life, should occasion its cessation, is sufficiently intelligible. But there are others which defy or elude our present means of investigation. You know I am saying nothing new when I tell you that such are the cases of death from the poison of some serpents; as, for example, that of the *Cobra de morte*. Dr. Russell, in his History of Indian Serpents, relates an instance, which Mr. Bourchier communicated to him, of a stout Arab, bitten by this snake, which is only from six to nine inches long, and very slender in its thickness; and who expired almost instantaneously, after exclaiming that a snake had bit him. A Gentoo boy, thrusting his hand into the wall of an old house, was bitten in the hand, and in less than ten minutes expired.

A Sepoy was bitten in the ankle by a large snake, believed to be a *Cobra de capello*, and was brought to Captain Gowdie's house, within a quarter of an hour after

the accident. His jaws were locked, his eyes fixed, and very little sign of life remaining. Four large punctures were visible on the ankle, to which *eau de luce* being applied, the man gave marks of sensibility, by drawing up his leg. Two bottles of Madeira wine were then made warm, and the jaws being forced open, so as to introduce a funnel, almost the whole of the wine, in the course of half an hour, was poured down. The application of the *eau de luce* was continued constantly for three hours. The patient was now totally without any sense of feeling whatever; and, had it not been for a gentle heave of his breast, every two or three minutes, Captain Gowdie would have thought him dead. He remained in this torpid state forty hours, and then began to show signs of returning life. It was twelve hours more before he recovered his speech. He continued many days in a languid state, but at length became one of the stoutest men in the regiment. No mention is made of either swelling or discoloration of the ankle.

An instance, not less interesting, is related in the eleventh volume of the Asiatic Researches, of his own case, by Mr. Macrae, civil surgeon at Chittagong; where the puncture of one fang, from a very small snake, producing an injury scarcely visible, nearly proved suddenly fatal. Nor in this case did any particular appearance arise in the part. Mr. Macrae ascribes his recovery to taking, in quick succession, considerable doses of Sp. Ammon. Comp. The effects also of the poisons of Ticunas and Lamas, and of the Upas, and of the Hydrocyanic Acid, are very well known.

But injuries apparently the most trivial, and where no suspicion can exist of any poison being introduced, are sometimes sufficient to destroy life. A stout healthy young man trod on a nail in the floor of a room, which went through his shoe, and very slightly punctured the under surface of his foot. On the tenth day after the accident, he began to complain of stiffness about his throat, and wandering pains. In three days he called on his apothecary for medi-

cine to relieve them, and died with locked jaw and the most violent opisthotonos, on the following morning, only fifteen hours from his being out. Yet on examination of the body after death, the original injury was scarcely visible; nor could the smallest morbid or preternatural appearance be any where detected by the most careful examination.

I might here also cite the mysterious influence of the canine, or hydrophobic poison; which, after remaining apparently dormant, sometimes for months, but exerting all the while a secret and deadly influence, at length, with a giant's arm, invades the constitution, producing one of the most terrific diseases in the whole catalogue of human miseries; for which, let whatever may have been pretended, no remedy has yet been discovered; and always cutting off the unhappy sufferer, in three or four days at farthest, by a miserable death.

In other cases, we find extensive diseases of the most important viscera, of the brain,

and of the limbs, borne for years before they produce death; and sometimes even entirely cured, after a long and painful struggle. A girl of six years old, after having been declining in health from August, 1808, was attacked about the following Christmas with sickness and head-ache, and after a time became unable to see. The pupils, however, contracted on the approximation of a candle, for a considerable time afterward. At length it became quite insensible. This child lived, with various fluctuations, for a period of near six years. In all this time, although having occasional delirium, I always found her able to give a rational answer to any question I put to her. She became gradually weak, and finally anasarcous, and at last died suddenly. On examination after death, I took from the brain a full ale-quart of fluid. There was a tumour in the cerebellum about the size of a dove's egg, of that texture which is commonly considered scrofulous; and a number of smaller ones of a like nature were studded over the basis of the cranium, producing ulceration of the

bone wherever they lay, so as to destroy in many points the roofs of the orbits. On the other hand, an old friend of mine, apparently in perfect health, sat down one morning to make his will, for the express purpose of leaving some freehold property away from a drunken and profligate nephew, who was the heir at law, to another whom he justly esteemed, and in an instant fell dead upon the table, with the memoranda of his intentions before him. I dissected the body and the head; but the only mark of injury, and no doubt the cause of his death, was a small extravasation of blood under the pia mater, investing the pons varolii, not exceeding, indeed scarcely amounting to, a drachm. I may mention, in passing, that this gentleman had always suffered more or less from complaints which he and his medical attendants considered to be bilious, and resulting from an excess of that secretion. The liver and its ducts were, however, perfectly sound; but the cystic duct was completely obliterated, and the gall-bladder, a mere small and empty bag. — Such, so unaccountable and so

checquered, are the states, and fates, and chances, of man on this globe, as it respects his corporeal existence and the integrity of his frame.

But we must not overlook his mind; the powers with which it is endowed; the projects by which it is inspired; the emotions by which it is excited; the disappointments to which it is exposed; and the hopes by which it is relieved and sustained. It may indeed be asked, what has all this to do with Surgery? — I will tell you, Gentlemen, what it has to do with Surgery. Familiarized with others as we must necessarily be, under all the contingencies and vicissitudes of life, in every rank and station, from the imperial diadem to the meanest badge of poverty and distress, our sentiments, and the promulgation of those sentiments, must always have an important influence on the tone, the conversation, and perhaps often on the conduct, of the society with which we are intermixed, and who look up to us for relief in the most trying and unexpected incidents of their

lives. We are not indeed to pry into the secret concerns of those who require our assistance; but we may eye their tempers and their feelings with a philosophical, though silent observance, in order to note their pathological influences. Nor can it always be a matter of justifiable indifference to us, (such are the real, but various and generally *debilitating* effects of the passions) even as it respects the *treatment* of our patients, whether injuries are received by them, or sudden diseases invade them, or latent diseases become developed, under the fortitude of heroism, or the vacillations of timidity; under the consciousness of rectitude, or under the compunctions of guilt; under the anxieties of embarrassment, or the satisfactions of competence; under unprovided disappointment, or unexpected success; under the fretfulness and irritability of a peevish temper, or the composed resignation of philosophy and religion; under the finer sensibilities of affection and virtue, or the careless and stubborn obduracy of habitual crime. In many points of view men are to be considered

as modifications of material substance, for such they are; in others they are to be looked on as living animals, for such also they are. — But there are others in which they must moreover be looked upon as moral and intellectual, as accountable and immortal beings. *Surgeons* must not forget, or overlook, that higher principle in mankind on which their chief dignity and duty, their powers of contemplation and reflection, their present and final responsibility, their happiness and composure, and often their greatest sufferings, in consequence, depend.

> "For see, how all around them wait
> The ministers of human fate,
> And black misfortune's baleful train!
> Ah! show them where in ambush stand,
> To seize their prey, the murd'rous band!
> Ah, tell them they are men!
>
> "These shall the fury passions tear,
> The vultures of the mind;
> Disdainful anger, pallid fear,
> And shame that skulks behind.
> Or pining love shall waste their youth;
> Or jealousy, with rankling tooth,

That inly gnaws the secret heart;
And envy wan, and faded care;
Grim visaged comfortless despair,
And sorrow's piercing dart.

" Ambition this shall tempt to rise;
Then whirl the wretch from high;
To grinning scorn a sacrifice,
And bitter infamy.
The stings of falsehood these shall try,
And hard unkindness' alter'd eye,
That mocks the tear it forced to flow;
And keen remorse with blood defil'd,
And moody madness, laughing wild,
Amid severest woe.

" Lo! in the vale of years beneath,
A grisly troop are seen;
The painful family of death,
More hideous than their queen,
This racks the joints — this fires the veins;
That ev'ry lab'ring sinew strains;
Those in the deeper vitals rage.
Lo! poverty to fill the band,
That numbs the soul, with icy hand;
And slow-consuming age."*

Not that I wish Surgeons to be gloomy fanatics, or expect that they should all become abstruse metaphysicians, or subtle

* Gray.

disputants in theology or in ethics; but there are among us individuals, and I trust there always will be, so furnished with talent, so prepared by education, so favoured with opportunity, and so animated by philanthropy, that they will feel it their duty, and find it their pleasure, to pursue our profession, not merely in order to obtain a respectable provision, or to amass an honourable fortune, but also to extend the boundaries of science, and to benefit succeeding generations. Such persons will dive deep into principles. They will endeavour to survey human nature in its widest range, and to scrutinize its minutest relations. In short, they will fully adopt the sentiment of Chremes in Terence, so beautifully and philosophically inscribed by Sir William Blizard over the entrance to his dissecting room: —

"Homo sum — humani nihil a me alienum puto."

LECTURE II.

March 20.

The body being made up of a combination of different systems of structures, interwoven with each other, possessing distinct functions, but nevertheless in a state of mutual dependence, and reciprocal influence, it may be proper to take a view of them both separately, and in the relations they bear to each other, in a natural state, before we attempt to analyze their morbid derangements. Indeed, it is of the greatest importance to us in practice that we should possess and preserve a correct picture or map of them in their several relations, whether local or functional, at the same time, in our minds; that we may thus be more promptly aware of their communications with, and effects upon each other, both

in health and disease. For no considerable derangement can happen in any one of these systems, without others, and generally all of them, being either directly or indirectly affected; or in such danger of becoming so, as to call for a prepared and vigilant eye, on our part, to watch them well and carefully, that we may be ready to detect their earlier, as well as their more advanced deviations from a healthy condition; and also in many instances to foresee the probability of such aberrations, and as far as possible to provide against them; to resist them as they arise, and even after they have been already counteracted or subdued, to guard more effectually against their recurrence. And it will always be an object with the well-informed and judicious practitioner, never, if he can help it, to attempt the relief of one system, without considering what effect his measures are likely to have upon others, so as to avoid any real and permanent injury to the rest.

The opinion is now very generally and justly exploded, which was formerly entertained, that growth is merely the unravel-

ling and developement of parts, which first pre-existed in miniature. On the contrary, we see that different structures are *successively* built up, for the formation of the complete individual. Some of them are only for temporary purposes, and are to be rejected or taken away as soon as those temporary purposes are answered. And of those which are to remain, the progress does not go on equally, nor always contemporaneously. In the incubated egg of a sparrow, I found the two eyes of the chick at one period equal in bulk to all the rest of the body. In the early human fœtus, the head bears a larger proportion to the other parts than it afterward retains, and the sexual organs only arrive at perfection long after birth; and then attain it by a quick progression, after a long comparatively simple existence. It appears, therefore, that the several formative processes arise one out of another, in succession; that the previous establishment of some, and a good degree of confirmation of the parts they construct, is essential to the commencement and continuance of the rest, or for their own permanence and safety during the

production of others; and that thus the perfection and harmony of the whole are at last more effectually secured.

Let us commence by taking a general view of the sanguiferous system. For although this may, in some points of view, appear to require preliminary considerations, a similar objection might be brought to any other line from which we might propose to begin our enquiries. But this is the first by which we are able distinctly to trace the active operations of the principle of life and growth. It is for this reason that the obvious progress of the incubated egg, which is so readily examinable in all its stages, has so powerfully attracted the careful attention of the greatest anatomists and naturalists, from Aristotle downward to Harvey, Malpighi, and Hunter. The examination of this interesting object exhibits to us the first visible result of vital action, by the production of that distinct and diffusible substance, out of which all the various parts to be evolved are to receive their supply, both for the support of their substance, and of their

actions; and this is found first in a small spot, being contained in a circumscribed bag, or vessel, endued with the power of action and re-action on its contents, which causes it to exhibit a pulsatory motion, by alternate contractions and dilatations. From this, tubes are soon found to proceed, that extend the range of the fluid, which now enters into them also; and from these again, others originate, which are formed and nourished by the same fluid, and a circulatory system is at length established, by which it is transmitted along one set of vessels, and returned to the heart, its original source, by another set; provision being made, during the formation and growth of the whole series, infallibly to secure both the passing and returning currents in their right track. Nor unless these different branches of the sanguiferous system are properly formed, established, and connected, can the animal perfectly carry on and continue its functions. Some deficiencies and derangements do not in all cases stop the growth of the fœtus; but they generally render it unable long to sus-

tain its vital energies, after the time has arrived for its separation from the parent; so that it speedily perishes under exposure to circumstances, which one perfectly formed is fitted, and would be able, to endure with impunity, according to the place in the general system of being for which it is destined.

So truly wonderful, so far surpassing all our powers of conception, is the gradual, but certain production of such a circulatory system, fitted up in all its minutest parts with the exactitude and co-adaptation which our dissections and injections now enable us to demonstrate, and all this beginning and going on in a substance originally a mere pulpy speck, that we cannot feel surprized at the crude and imperfect notions of the ancient philosophers and physicians respecting it, nor at the incredulity with which its discovery in later times was first received. The paucity of their means of investigation, and of communication with each other, made their pursuits in a great measure for a long time to consist of repetitions of the

same incipient enquiries, and made natural knowledge advance with lame and tardy steps. Aristotle, whose enquiring and comprehending mind had been led to numerous and attentive examinations of the production and growth of animals, noticed this first appearance of the heart in the egg on the fourth day of incubation; and observing that from this palpitating point the evolution or formation of other parts seemed to commence and proceed; and finding, as he tells us, on dissection, that all the other organs of the body were permeated by the veins, which derived their origin from thence, and being ignorant of the true use of the arteries, which are found empty in the dead body, concluded that the blood was formed in the heart, in all the future stages of life; and was from thence pressed into the veins, out of which it had no natural exit; but remained in them as a vital juice, with an undulatory motion, to moisten and warm and nourish the parts to which it was distributed. This opinion laid the foundation of the Galenic theories, and remained, with various mo-

difications, till Harvey, by anatomical indagation, or, to use his own words, "*dissectione anatomica, multiplici experientia, diligenti et accurata observatione*," produced those irrefragable proofs of the circulation, which are detailed in his immortal work. The complete demonstration of such a system of vessels in animals, as his discoveries presented to view, must indeed at first have afforded a grand and stupendous object of contemplation, and may soften the derision we might be inclined to feel against Riolan, who was Harvey's warmest opponent, and who has a chapter expressly entitled, *Quod sit* IMPOSSIBILIS *sanguinis totius circulatio, sæpius in die repetita.* For even now, accustomed as we are to behold it, in all the lustre of its present evidence, and familiarly as we are habituated to reason from it, its first formation and establishment continue, and probably ever will continue, a mysterious and inscrutable process. And it seems difficult to suppose that a person of a truly philosophical mind, not pre-occupied by some other object, could now pass through our museums, and atten-

tively behold the developement of a system of vessels, apparently so simple in its commencement, and ultimately extending into ramifications so infinite in number, so varied in appearance, so exquisite in tenuity, so intervolved in complication, so diversified in functions, and so united in purpose, without some sentiment approaching to adoration. Let me here employ the words of the late Dr. Gregory: —" *Nobile opus, nec nisi* Uni *excogitandum.*"

Every organ and part of the body, however, evidently derives its origin and support from the action of some blood-vessel or vessels which are produced for that specific purpose: and nothing surely can be more curious and beautiful than to behold vessels, having their origin from the same source, and conveying the same identical fluid, effecting such an immense variety of results, giving existence to so great a number of parts, and supplying them with but one and the same material, out of which they derive all that is necessary to support themselves, and to carry on their respective

functions in the animal œconomy. In order to this, they ramify and intervolve with a minuteness that in many instances eludes our nicest research, and, in consequence of their combinations with other parts, carry on an incessant and multitudinous series of chemical changes. Some, indeed, have been ready to suppose, that the various parts of the body are nothing else than an endless tissue of vessels, and that they differ only, or chiefly, from each other, in the modes of their subdivision and arrangement. This, however, is a notion too absurd to bear examination, and contrary to the most manifest facts, which prove to us that every part, besides having vessels and nerves of its own, has also its own peculiar or parenchymatous substance, by which it is essentially distinguished from others. The masterly observations made in this Theatre by Sir Anthony Carlisle, in one of his lectures on this subject, will be well remembered by all who heard them, and render any farther allusion to it at present superfluous.

All the different parts, then, of which the body is composed, derive their parenchymatous substance from the supply which the vessels afford them; and it is the duty of the Surgeon to make himself as fully as possible acquainted with the origin, course, and distribution of these vessels, and with the peculiar nature and qualities of the respective and distinct substances which are maintained by their instrumentality.

In studying these, as we perceive that a variety of structures are built up, so we find that they are produced and perfected in a certain order, form, collocation, and relation to each other; and that not only is a provision made for regularly conveying to each part its requisite portion of the nutritious fluid, and returning that from which the appropriate supply has been selected; but that also a peculiar set of vessels, of wonderful tenuity, but of equally wonderful fabric and efficiency, is appointed to absorb and carry off from the parenchymatous substances, and from the vari-

ous interstices and surfaces of them, such superfluities, or spoiled materials, as may from time to time present themselves; and that these vessels essentially act in modelling those parts to which they are distributed, and in accommodating them to various novel and unnatural conditions, into which they are occasionally brought; although, in the performance of their functions, they are not unfrequently also the means of introducing into the constitution things that are deleterious, and sometimes fatal; and even of propagating the evil effects of injuries inflicted on themselves, with violent and alarming rapidity, to other parts. These vessels unite with others of a similar nature, which take up the nutritious matter from the organs of digestion, and terminate in a common tube, which pours their contents into the returning blood, to combine and assimilate with it in the course of its recirculation, that all which is useful may be employed or retained, and all that is unsuitable and effete may be carried off by the proper and appointed organs for their separation and ejection. The san-

guiferous and absorbing vessels are thus rendered contributory to each other's purposes, and probably are so, by more frequent and less circuitous communications, than this larger, more remarkable and important one, the Thoracic Duct.

But as this formation and arrangement of parts would alone go but a very little way toward accomplishing the purposes for which life is bestowed, while the powers which complete that formation and arrangement are employed in this work, they are also engaged in constructing another apparatus within the body, by which it is to be made fit for a state of existence independent of its parent; to become capable of possessing and maintaining a variety of relations toward external objects; of enjoying consciousness; of providing for its own support; and of continuing its kind. To answer these, and other important ends, the nervous system is formed, and connected with every other part of the body, all the functions of which are more or less subjected to its influences, and some are

altogether and absolutely dependent on its integrity and health.

Of this system, the brain has been considered as the root, or center: the nerves, when their connection with it is destroyed, being rendered incompetent to their offices, neither communicating sensation, nor conveying volition. But recent observations have shown that this view of the subject is imperfect, and has led philosophers somewhat astray in their investigations. The examination of fœtuses which have been born without brain, or with a very imperfect one, demonstrate that neither the nerves nor the organs of sense are dependent on the brain for their formation; and that, as long as the fœtus retains its connection with the mother, its nourishment and growth may go on, without a proper or perfect brain of its own. It is probable, therefore, that the nerves in these instances do answer important purposes, as long as that connection is continued; and derive, while in utero, from the mother, a certain portion of that influence, which af-

terward should be supplied by the brain of the individual itself, and for want of which, when born, it speedily perishes.

The observations and experiments of Volta, Sir Humphrey Davy, Sir Everard Home, Professor Brande, and others, have thrown much additional light on the subject of cerebral and nervous influence; and show that one most important, and perhaps the primary view to be taken of the nervous system, is that of a diffused electrical apparatus, by the operations of which the actions of the blood-vessels, in their respective courses, are regulated, and those chemical changes are effected in the material supplied by them, to every part of the body, that are essential to the secretions of every kind; and, of course, to nutrition, which must depend on a due separation, combination, and arrangement of the elements of which the different organs are composed.

A more obvious, and therefore more marked influence, but most probably of an

analogous kind, is conveyed from the brain through the nerves to the involuntary muscles, and a still more sensible and conspicuous one to those which are under the controul of the will, in order to excite them to their proper actions. But we see also that the nerves are capable of conveying to them the Galvanic influence, and to excite them to powerful contractions after separation from the body to which they belonged. So that neither are the nerves dependent on the brain for their existence, nor for their inherent fitness to communicate to the excitable fibres that influence which causes them to act, and which in the living body they conduct from the brain, and the medulla spinalis. But they are dependent on the brain for a permanent, and continuous, and definite source and direction of this influence, without which their powers soon become uncertain, and irregular; and finally, exhausted and extinct.

That other nerves should communicate the impressions they receive, which are

called sensations, to the mind, or conscious principle, from their extremities by means of the brain, is a fact still more deeply mysterious. For the nerves have no power to receive *sensations* apart from their connection with the brain; nor the brain itself, except through the intervention of the nerves; neither are both together competent to such a result under all circumstances; so indeed as to show the necessity of admitting that conscious principle, as one totally distinct from material composition and arrangement. In some cases we can explain this incompetence, by observing a mechanical impediment to the continuity of their relations; but in no case are we able to comprehend their competence to the effects under our notice; nor do any of our researches seem to have advanced us a step toward any probable method of doing so.

Equally, if not more remote, are we from any power to explain the connection which subsists between the brain and what have been called the internal senses, or

the mental faculties and propensities. Memory, thought, judgment, the passions, and their antidotes, far elude our keenest speculations. We must take them as we find them—momentous facts, continually calling forth our careful attention; but an attention which places us on the simple ground of observers only, from which if we endeavour to rise, we inevitably fall.

But as all these are more or less connected, either by priority, co-existence, or succedence, with corporeal actions, it seems necessary, and is sufficiently comprehensible, that there should be an organ, or organs, by which the conscious principle might directly communicate with those nerves, through the intervention of which, the fulfilment of mental purposes, by the performance of those corporeal actions, is destined to be effected. And as it is not an incurious, neither can I discover that it is at all a reprehensible subject of examination, to investigate what parts of the brain more immediately subserve to the exercise of the different faculties or propensities which we

discover, by their corresponding actions, and where they in reality exist. Drs. Gall and Spurzheim, as you well know, have suggested, and to a considerable extent followed up, the observation and dissection of the prominent features and parts of the brain which they discovered in particular individuals, in whom any peculiar faculty or propensity had been remarkable; and also of the structure and evolution of the different parts of the brain, in animals whose dispositions and habits are most strongly marked.

I am neither, at present, prepared, nor inclined, to contend for the verity of the indications on these subjects which the gentlemen I have named have already published. But whether they be just or erroneous, I think I am still founded in asserting that the mode of enquiry they have pursued and recommended, although not the only one by which we are likely to gain any satisfactory knowledge on the subject, is at least one of the most important. For to this should certainly be added a careful examination of the brains of persons who,

by injury, or disease, have had any particular faculty impaired or abolished, and noting how far these deficiencies correspond with the assumed offices of the parts affected. And it ought not to be forgotten, nor lead to any contempt of the theory in general, that in entering on a field of investigation so vast, so variegated, and so much dependent on minute and discriminating anatomy, many erroneous steps, and inaccurate views, should at first be taken. But these do not impugn the propriety of the investigation, nor of the means of pursuing it. I must, however, observe, that I attach less importance to the form of the skull than Drs. Gall and Spurzheim have done. Nor do I perceive that the existence of the organs for the appropriation of which they contend, as separate and defined, necessarily implies a particular formation of the bony case in which they are contained, any more than the existence or office of the eye depends on the graduations of the socket, or the greater or less protuberance that the eye itself assumes, in different nations, or in different individuals. In all

probability ages may elapse before a sufficient collection of facts can be accumulated, to form a systematic code, worthy of general reception, of the laws which govern this part of the animal constitution. But the search for them can be neither unreasonable nor improper. The faculties and propensities of animals may be examined as innocently as their corporeal structures, which indeed are the real and only instruments by which these propensities and faculties are made manifest. To suppose that if we could discover the seat of any of these, or, to speak more correctly, the situation and structure of that part of the nervous system, by which the organs conjoined or allotted to them are first brought into agency, and from whence their influence is propagated to the structures, and combinations of structures, which obey their impulses, we should thereby loosen the bands of morality, and afford the criminal passions an unlimited indulgence, is as groundless as to imagine that because we know the structure of the eye, and the ear, and can point out the uses of their consti-

tuent parts, and of the whole in their combination, and can demonstrate the muscles and nerves by which they are directed and employed, we should therefore endanger an immoral, or injurious use of them. Rather must it tend more fully to strengthen the virtuous resolutions of every one bent on the attainment and preservation of mental and moral excellence, to feel the salutary alarm of a conviction, that if he disorders his frame by criminal practices or excesses, he will deteriorate from the vigor and perfection of his intellectual habits and exercises; and that if he does not controul the gratification of immoral inclinations, there is a certain connection, of strong, though perhaps not of indissoluble necessity, which will cause him to suffer more or less in his bodily perfection; while to add the force of habit to intellect and virtue, is to keep his outward frame in a state adapted to the harmony and improvement of his mental and his moral nature. The *mens sana* and the *corpus sanum* are perhaps more intimately allied than many who have not attended to the

subject are aware. Nor is the remark either philosophically or ethically untrue, that vice and its consequences are fastened to one chain, although they do not always keep an equal pace.

At all events, we may congratulate ourselves on the greater and more accurate degree of philosophical examination which the nervous system has lately attracted; apart from those speculations, falsely called *metaphysical*, but more justly denominated by Sir A. Carlisle *ultraphysical*, with which they were formerly blended and entangled, to the injury of calm investigation, and of sober induction. I trust we are more effectually learning to avoid those rapid transitions from few, and insulated, and partial facts, (facts, however, notwithstanding,) to general conclusions, which have for so many ages been the bane of medical science. Deeply should this, among the many wise observations of Lord Bacon, be impressed on the mind of every student,—not to check, but to animate his enquiries; not to damp, but to regulate his zeal:—

"*Inductio quæ procedit per enumerationem simplicem, res puerilis est; et precario concludit; et periculo exponitur, ob instantia contradictoria; et plerumque secundum pauciora quam par est, et ex his tantummodo quæ prostæ sunt, pronunciat.*" — The disposition to form hasty inferences, which is so apt to beset that period of our education when the light of science first breaks in upon the mind, and when the charm of novelty is so apt to inspire a seductive and unwatchful confidence, must be guarded against by a modest and teachable temper, lest we too quickly mistake the dawn of the sun for its actual rise, and lose our way among the mists, which are only beginning to disperse.

But to proceed: — The systems to which I have already adverted, enter into the composition, supply the materials, remove the superfluities, and regulate the functions, of every organized structure in the body. Arteries, veins, absorbents, and nerves, pervade the texture of all, and are essential to the support and the actions of all, how varied soever may be their essential or

subordinate uses. It is by the local or general derangement of some or other of these systems, that all diseases begin and proceed; and by their restoration, as far as possible, to a natural and harmonious state, that the cure of these diseases is to be effected. We are not, we cannot be, we must not attempt or affect to be, magicians in science. It is indeed certain, that many things, indisputable in their truth, elude all our powers and present means of explication, but must nevertheless be admitted, and held fast, as facts, so far as they go. But we must not be unmindful of the propriety and necessity of studying the principles, as well as the facts, in every case. We are not merely to consider what remedy will alleviate, or cure a disease, but also *how* it alleviates or cures it. What effects, advantageous or disadvantageous, does it produce in the course of its operation, upon the blood-vessels, the absorbents, and upon the nerves of the parts affected, or of the constitution as a whole; and how may we attain the good, and avoid, or overcome the evil, if there be any, which lies in our way. This

is the true philosophy of Medicine and Surgery. Destitute of this, we must verge to empiricism. Instructed and habituated to this, we advance with humble security; we multiply our own resources; and in proportion to our real progress, and consistency of conduct, we shall deserve the confidence of those who look up to us for aid.

What then, we must next enquire, are the structures and offices of the numerous parts into which all these systems enter? How are they united and related to each other, so as to form a harmonised and perfect whole; and how is this whole, and the portions of which it consists, related to the beings, animate, or inanimate, which surround it? How does it receive and compound its supplies, and reject superfluous and noxious intermixtures. How are the nutritious substances disposed of and arranged in its various structures? And by what means, and subject to what results, may any of those structures be violated, disturbed, diseased, or destroyed.

First, we must direct our attention to that series of organs, on which the support of the whole animal fabric, after its exclusion from the womb of the mother must depend; and the health, and actions, and diseases of which, have a constant and important influence upon the whole; while they, in their turn, are liable to be affected by the condition of any other part. In all cases, the state of the organs of digestion demands our distinct and watchful attention. It is to them that the chief materials by which the whole structure of every part is supported are first conveyed, in order to undergo the first processes of assimilation. It is from hence the blood-vessels derive their supply, through the intervention of the absorbents. It is into them that the most important secretions are passed, for the production of which, large, and numerous, and highly organized parts are constructed. To the digestive organs, and their appendages, a great portion of the blood itself is distributed, and large, important, and complicated plexuses of nerves are allotted, under whose influence their offices are regu-

lated; and this, for the most part, without the consciousness or interference of the mind. Organs which form so large a part of the whole frame, which are essentially necessary for the sustenance of the whole, and for the repair of such injuries as may occur, must necessarily possess an extensive and perpetual influence over the whole. Unless they go on acting aright, the constitution must be more or less disturbed; the nutritious fluid will be deficient, or redundant, or badly prepared, and morbid actions may be naturally expected to arise in various parts. Nor are those supplementary organs, or their proper actions, to be overlooked, which separate and eject the fæces. That the effects of disorders in the abdominal viscera, in producing and modifying many local, as well as constitutional diseases, should have attracted so large a share of the attention of that distinguished member of the Council of this College, whose publications on the subject are, or ought to be, in all your hands, and who so frequently and eloquently introduced them in his lectures in this Theatre, is a proof of the wise and

extensive range of his professional studies; and contributes, with many other eminent qualifications, to hold him out as an example to all our members. Mr. Hunter appears to have devoted less attention to this part of the animal economy than to some others; but he prepared the way for his successors to do so, by his examination of the laws of life; by a multiplied accumulation of beautifully illustrative preparations, from many animals, contained in this Museum; by his notice of the effects of the gastric juice on the stomach itself after death, and by his investigation and account of the sympathies which are established, between the different parts of the body.

Thus far, however, we have reached only to the general substance, out of which the living fabric of the human body is built up, — the oil, and wick, as it were, of the lamp of life. We must now proceed to consider how the flame itself is supported; — by what means that form we behold flourishing in health, in beauty, and in activity, is preserved so long from becoming a cold, dis-

gusting, inanimate corpse; and by what arrangement it is, that the very atmosphere, which is the agent for reducing man to his original elements, is so made to be the essential mean of his conservation, that the privation of it, for a few short minutes only, becomes the certain cause of his inevitable and immediate destruction.

We learn that after the Creator had first formed man out of the dust of the ground, *he breathed into his nostrils the breath of life, and man became a living soul.* A phraseology indicating respiration, or the consecutive receptions and transits of air by appropriate organs, to be the prime and indispensable requisite of vitality. So it is to all animated beings without exception. For totally immersed in oil, either volatile or fixed, which altogether excludes this process, no vegetable can grow, nor any animal body continue to live. Indeed, life and breath are almost synonymous terms. No object in Anatomy and Physiology is more curious and important than the reciprocal and uniform correspondence which

exists between the circulation and aëration of the nutritious fluid; each process being essential to the continuance of the other, and both to the energies of every vital part. By his superior adaptation for the regular performance of these functions in their due harmony, man is rendered the most universal inhabitant of the globe. From the most frozen regions of the north, which are clad in perpetual snow, to the scorching heats of the equatorial line, and under transitions which no other animal but himself, and those most essential to his uses, can with impunity endure, man breathes, man pulsates, man lives, — and we must indeed also add, man dies.

In the hasty view to which I must limit myself, of the important organs of respiration, I shall begin with that to which I have just alluded: "into his *nostrils* was breathed the breath of life." Nor is the configuration and appropriateness of this first part of the breathing apparatus, that is so constant, and so peculiar in man, unworthy of our regard; for to man, perhaps more than

to any other animal, is this the gate through which the air usually first passes in its way to the pulmonary cells; presenting him in its course with fragrant odours; or warning him of noxious qualities, by which it has been impregnated. As the organ of smell, and as a feature in physiognomy, the human nose has naturally commanded attention at all times. As a passage for the air in breathing, it has not been so much studied; but we may hereafter have an opportunity to remark how fitly it is constructed, to conduct the respirable atmosphere directly behind the epiglottis, and yet anterior to the pharynx, into the trachea, in every inspiration; as well as to return that which has been breathed, in a direct and opposite line, through the same channel, when there is no occasion, or inclination, to employ it in speaking, or in other exertions which call for its emission through the mouth.

But whether the air go into the bronchial tubes by the mouth, or the nostrils, it is made to pass into countless myriads of cells

in the lungs, and to return from thence about 30,000 times, or more, every 24 hours; in order to impart through the coats of those cells to the blood circulating through the infinitely minute sanguiferous tubes which ramify upon them, that by which vitality and warmth are to be sustained, and to carry off from them a noxious substance, or substances, in a gaseous form.

And here, as by the digestive organs, may death and life enter in at the same door. The most virulent poisons may be wafted on invisible wings; and a pestilential blast may at once strike down the giant, or the hero, who, a moment before, bade defiance to armies; while the pale and emaciated sufferer, from violence or long disease, may perhaps quit his bed of languishing and pain; and inhale health and vigour in the reviving breezes from the fields, or from the sea.

Farther than this, it is not my purpose, at present, to notice the formation of the

blood. Its analysis is taught in our medical schools, as a part of our initiatory studies ; and it has been well considered in the first course of lectures delivered in this place by Professor Wilson, and afterward printed.

LECTURE III.

MARCH 22.

HAVING in the last Lecture noticed the processes by which the blood is produced, let us now, for a moment or two, turn our attention to those essential parts in the human body, which it is the final purpose of this plastic compound to form, to nourish, and to repair, and to those arrangements which are made for the due employment of parts so constituted and constructed.

And we should first, I think, notice the organs of sense, the organizations of which are first formed and protected; to which all the rest are to be ultimately subservient, and which, in fact, constitute the essential characters of every animal, and

define its capacities and uses in the world. As soon as ever the blood-vessels are brought into active operation, an advance is made to the production and defence of these mysterious organs. How far anterior in its developement and perfection is the head, the seat of them all but one, and not indeed exclusive of that; and how far does the cranium itself, which contains them, at first exceed the rest of the head in bulk and growth. Let us not look with a careless eye, or an unheeding mind, on this apparently pitiful and conical form, which the fœtal cranium at first assumes, while it is to be altogether sustained by its parent, or to the seeming neglect of progress in the portion of the head below, for which no exercise will be called, till it is destined to procure its own supplies by its own exertions. Let us see, within the enclosures and partitions of that almost ugly box of elementary pulp, the advancing arrangements of an eye from which intellect is to beam, and affection to dart its tenderest glance, and anger its fiercest threat: an eye more complicated, perhaps, then, than when fully fit-

ted for its uses, since the membrana pupillaris, that faithful and secure protector of the perfect form of the visual curtain, is then entire, vascular, and efficient. Let us look at the elaboration of the complicated labyrinth of that ear, on the nice symmetry and exquisite sensibility of which all the delights of conversation, all the enjoyments of music, and the possibility of acquiring or communicating them, primarily depend. Let us mark the internal arrangement of the nostrils; their bones, their sinuses, their cells, their membranes, and their glands; their fine and tender nerves, overspreading their whole surfaces, under a competent cuticular protection; preparing them to transmit air, to communicate delightful odours, to distinguish hurtful from salutary substances, and to warn us of the first approach of many morbid affections. And let us not overlook the tongue, at this period so closely immured from invasion, by which the first delight of conciousness is to be enjoyed, in the delicious fluid preparing for its sustenance, and suited to its desires. And when to all this is added the

elaboration of the skin, the organ of touch, in all its modifications, and also of extensive transmission and absorption, both of good and evil matter, we seem to have before us one of the most sublime objects of interest that this lower sphere can present. And this interest is abundantly increased, when we advert to that conscious power, which is the center, the record, and the employer of the whole system; and that engages, directs, and enjoys the whole range of the powers entrusted to it, in their own appointed, distinct, and incommutable relations.

And we know by what means these powers are applied, and made effectual, to the purposes for which they are bestowed and adapted. For the instruments of locomotion (and let us not be unmindful that these are not merely instruments of motion but also of equipoised rest, and vigilance) are superadded. We know that they constitute by far the largest, and most ostensible parts of our frame. Perhaps, indeed, Surgery is more occupied about them than about the masters, who command and con-

troul them; so far at least as its ordinary *engagements*, but never farther than its *principles* reach.

When the limbs are exerted, when the body sustains a load, or awaits with firmness, or with vigilance, an expected attack; when the eye looks, or the ear attends, or the fingers touch, or the nostrils expand to scent the air, or when the tongue tries the properties of substances which are to pass over it into the alimentary canal, or to be rejected as noxious or distasteful; all this is accomplished by the agency of moving and contractile fibres, attached to determinate points, for the most part of solid substance, from which they may, and do, exert their force, in the most perfect accordance, though with infinite variations, and countless concurrences, in order completely to effect their numberless uses.

And what is the nature and arrangement of this solid substance, and what are the multiplied forms and fittings of its parts? Hogarth has observed, that solid objects should be considered, (he spoke, you know,

as a painter, but at the same time as a most true observer,) as only thin shells, composed of lines; and I will frankly confess to you, I never look at a skeleton without a degree of humiliation, bordering on confusion; always thinking I have instantly opened before me an immense volume, obvious in the gross, but profoundly minute in the details, of mathematical diagrams, almost infinite in complexity, stupendous in design, perfect in exactitude, faultless in material, and most exquisitely beautiful in the symmetrical connections of its parts. We are told that Galen, by the sight of a skeleton accidentally formed, perhaps by ants, and presenting itself before him, was reclaimed from infidelity. If, in addition to this rude and unprepared object, he could have had the advantage of contemplating the labours of Albinus and Weitbrecht, showing the proportion, the order, the connection, and the mutual dependence of the whole compages, with what emotion must that great, and once idolized genius, have been filled! My friend Mr. C. Bell, has said, that he once challenged a scientific architect, who is de-

ceased, to produce a single principle in the art of building, which he could not exemplify in the construction of the human body; and I am confident he would have done it. There are ample materials; and no one can doubt his ability to explain them.

This locomotive apparatus, we find to consist of about 250 bones, in their perfected state, and of many more while in the fœtal state, before the epiphyses, and shafts, and masses, are united. Of these each portion originally possesses its own distinct centre of ossification. The spinal column alone containing more than 100, which equally, by the incompleteness of their bony junctions, and the elasticity of their cartilaginous ones, adapt the mature infantile structure for its passage through the pelvis, in the process of parturition. Near 1000 junctures of various kinds exist, having either immediate or dependant movements, with 400 muscles to act upon them and direct them; beside the hollow and transparent muscles, which serve the internal functions. Ten-

dons, original, terminal, and inter-placed, are almost numberless; while hundreds of suitable ligaments, to adjust and sustain the actions and uses of all these organs, are demonstrable under our dissections. Appropriate secretions to keep them fit for their services, are provided in sufficiency, without superfluity; and their surfaces are so disposed, and their interstices so lubricated, lined, proportioned, and connected with other parts, that the mighty arms of Hercules, and the resilient limbs of Antæus, could maintain their struggles unbroken.

The continuousness and exact proportions of all the arrangements from fibre to fibre, and from fasciculus to fasciculus, to an entire muscle; the motions of the muscle over contiguous parts without impediment, the connections of its fibres with those of the tendinous substance belonging to it, the insertion of it into bone, and the protection of the whole from exterior disturbance, without any undue confinement of its exertions, are all secured by that fine material, which is interposed, with every

possible gradation of firmness in its texture for this purpose, betwixt every existing surface in the composition of every part, and called reticular, or cellular membrane, which we shall have occasion hereafter more fully to examine.

Of this it has been too hastily supposed that all parts entirely consist, only under different modifications; because after long maceration it still remains, however light and almost arachnoid in its texture, when the parenchymatous substances that were enclosed and imbedded in it are dissolved and disappear. To this highly important substance in the animal fabric, therefore, and its various arrangements and consistencies, in and between the parts, which at the same time it effectually connects, and effectually separates, the attention of every accomplished surgeon must be faithfully directed.

Nor may we overlook the minute, and curious, and safe, and effectual arrangements, which are made of the sexual

organs, male and female, and their correspondence in both for the continuance of our race; and not only for this purpose, but to superadd to it the

"Sole bliss of man which has survived the fall."

— To cement parental, filial, and fraternal affection, from the beginning of life to its close, in a state where virtue sows the seeds of her sweetest and most universal flowers, and converts a part, at least, of the wilderness of life into a garden.

The structure, and some diseases of the various parts of this important apparatus, it will be remembered, were ably and delicately treated on by my predecessor in these Lectures. But on this subject, as well as on most others, competent investigators know, that great and sometimes perplexing obscurities are still undispersed.

Let us also for a moment reflect on the organs of communication from man to man, and from man also to the inferior animals over whom he reigns. Of these there

are two kinds, the one audible, and the other only visible. The first comprehending speech and sound, in all their varied modifications; and the second the universal language of signs and looks, by which nations and individuals, unknown to each other, communicate their wants and their wishes; their resolutions to confer hospitality, to pause in doubt, or to inflict pitiless murder and revenge.

Speech, in the proper acceptation of the term, is one of the peculiar prerogatives of man; and the parts adapted to its fulfilment are fully constructed with a competence to all its purposes. By the natural and gradually acquired employment of these are all the different wishes, impressions, and intentions of the mind made known; from the half unconscious and instinctive cry of the suckling infant, to the powerful oratory of the statesman, who makes the senate to thrill with his eloquence, and pours forth, from a well-furnished mind, propositions, or objections, on the just, but difficult determination of which, the fates

of armies, of navies, and of nations may depend. But speech, and the instruments of speech, are, after all, merely *parts of* a present intermediary arrangement, betwixt one intellectual being and another. So that tone, and shout, and song, and groan, and scream, are all subdivisions of a vocal and distinct indication of the impressions and feelings of the mind. So far, therefore, as mind, or instinct, which surely is mind, to a perishable and limited extent, is concerned, man has much in common with many other animals.

In birds, who have, perhaps, as a class of animals, the greatest range of vocal power, the organ of sound is variously situated, in various parts of the bronchial tube, being not unfrequently near the division of the trachea, as it is going into the thorax. For us, and adapted to the more prompt, and more expressive and authoritative exertion of the voice, it is situated nearer to those parts which are to concur with it in *mental* expression: so that the exertions, and niceties of exertion, by which

the air is emitted from the larynx, modulated by the tongue, the teeth, the motions of the jaws, the nasal labyrinth, and by the finally adjusting and directing lips, are all made to concur in the expressions of the mind.

But man has not only the organ of voice, as the medium of enunciation of ideas and feelings, superior to any other animal, but he has also a more graduated, and perfect, and extensive competence to the communication of them, by the language of signs, which may be considered as a species of telegraphic intercourse, of universal utility and necessity. Each of these faculties seems to be conferred on some individuals more than others; and indeed on some whole classes of animals more than on others. The paper of our eminent philosopher, Dr. Wollaston, "On Sounds inaudible to certain Ears," published in a recent volume of the Philosophical Transactions, comes strongly in proof of this observation; and it is a very curious fact, recorded in the same work for 1781, respecting the Termites, or

white ants of Africa, that among the subdivisions of these insects, called the soldiers, those who are placed at the openings of cells, of long and circuitous extent, are able, on the approach of danger, to give an alarm by a sound, scarcely more than audible by man, on the emission of which, numbers of the inhabitants of the citadel within instantly rush forth, to protect the swarm which is threatened with invasion. It therefore seems admissible, that the faculty of hearing, which is only that of distinguishing vibrations of an elastic medium, may be confined to a particular organ only, in some instances, and in others, perhaps, generally diffused; with such delicate adjustment, as to influence the minutest animals, in their whole configuration, and produce a sense, if not of sound, yet of vibration, very analagous in its distribution and universality to that of touch.

Allow me, for a moment, to return to the subject of signs; for I shall have no fair opportunity to resort to it hereafter. Mr. Huber, in his treatise on ants, has

made a curious observation, which I think well deserves the attention and prosecution of naturalists — that they hold a telegraphic conversation by the motions of their antennæ. I will not commit myself here by either advocating or opposing this opinion: I only introduce the remark for the sake of exciting enquiry among those who have leisure and means to pursue it. But I certainly think this view of these parts not unreasonable; and I cannot deny the circumstances on which he has rested it. No one, however, who has had the pleasure to hear the Abbé Sicard lecture on the subject of the language of signs, and of witnessing the surprising and most useful and delightful perfection to which he has carried it, can, as I think, be unimpressed with the facts which he exhibits without reserve, from motives of compassionate and universal benevolence.

But if in this faculty, which reason and speech seem to render less needful to us, we are perhaps much inferior to many small and inconsiderable beings, we may nevertheless

find a source of interesting enquiry as naturalists; and Hippocrates has taught us the importance of remarking the imperfect and irregular, or involuntary movements which take place in diseases; and those alterations in the form and position of the body, from which an accustomed observer may often draw a prognosis of their terminations.

Thus, then, constructed and ordered, we have an organized, a complicated, and an harmonious frame, covered by a suitable investiture for its protection, its support, its symmetry, and its beauty,—an investiture of a texture apparently so simple, and yet so varied in the number of its parts, and of its functions, that I purpose, in the next Lecture, to call your notice distinctly to it, and to impress on the minds of students the propriety of devoting to it an accurate and careful attention. We have treatises after treatises on the diseases of the skin, but none of them begin, as they should do, with the requisite analysis of its structure; as if this were almost the only organ of

sensation of which an anatomical knowledge was needless, or at least subordinate. Perhaps no part of anatomy has been so much neglected; yet surely that extent of surface by which so much is absorbed, so much is transpired, so much is felt, so much is regulated, and all other parts are enclosed, has a powerful claim on our investigation. I shall be able to do but little with it; but I trust others will try to do more: for very numerous are the diseases and disorders and injuries of the skin, and of its appendages; many are its connections and sympathies with the subjacent parts. Surgical remedies are, in most instances, immediately applied to it, accomplish their influences through it, and are therefore greatly dependent for their effects on its actual condition; while many medicines exhibited internally, in a multitude of diseases, chiefly declare the evidence of their agency by their effects on this universal sheath of the whole animal frame. So that, if our anatomy of it be deficient, our physiology and pathology must be at least proportionally imperfect, and our remedial

resources more confined and less understood.

And now let me conclude this hasty and imperfect sketch of that wonderful machine, some of the disorders, diseases, and injuries of which, and their appropriate remedies, as far as I am acquainted with them, it will be my duty to lay before you, with calling to your recollection, that the numberless portions of which it is composed, are not, like the interrupted and tardy contrivances of human art, produced, arranged, altered, and repaired by slow and complicated labours, and additions of materials, which are first to be sought out, then to be separately prepared, and afterward arranged in their respective masses, having no power of securing or providing for their own increase and regulation: but here the whole derives its source from one formative impulse, one universal law, by which Omnipotence has impressed, on an unconscious and diminutive portion of matter, the power of commencing and continuing operations,

in the darkness of the womb, both the complexity and order of which the research of ages has been insufficient to develope. But however we may be humbled, we ought not to be appalled by this consideration. Truth has been compared, you know, to a treasure lying at the bottom of a well; and the depth of this well will be an excitement, and not a discouragement, to those who know the value, and have caught a glimpse of the beauty, of the wealth it contains; and to which, while it reveals an approach, demands, as an indispensable condition for its acquirement, diligence and zeal, and often an endurance of disappointment; — a disappointment which is not to discourage, but to re-animate that zeal to a patient resumption of its toil, and will confer additional verdure on the laurels which are to crown its success.

In concluding this part of my subject, then, gentlemen, allow me to say, — and I can assure you I say it with no insincere or hypocritical profession, — that I cannot quit this cursory view of the human body, with-

out mortifying feelings,—feelings arising from a consciousness of my own deficiencies. Life is too short for any individual to make much progress in supplying the voids which yet remain in our science; we must all, however, labour to make such additions to it as our abilities and opportunities may enable us. But little as we already know, our knowledge would be more insignificant than it is, if it did not conduct us, and incline us to conduct others, to an adoration of that infinite Wisdom and Power which presides over every department of the universe, and to a more ardent study of the works of Him, who has ordained the production and disposal of every substance in nature, from the thin and almost intangible gossamer that floats on the feeblest breath of the air, to the massy and immovable rock that withstands the most boisterous tempests of the ocean. With this impression, Mr. Abernethy once told you, in the happy parody of a line from one of our most celebrated poets,—

"An undevout *anatomist* is mad."

Such, too, were the feelings of Boerhaave and of Haller; in mentioning whom, I have named two of the greatest, and wisest, and best of men, by whom medical science has ever been adorned and advanced.

LECTURE IV.

MARCH 25.

GENTLEMEN,

ON considering in what method I should pursue the further prosecution of the anatomical part of the Lectures for the present season, I at first felt some difficulty: for various subjects of general importance have been so ably, and scientifically, and methodically treated, by the Professors who have preceded me, as to render the choice of a plan somewhat embarrassing. Lectures purely elementary, or simply demonstrative, would scarcely be adapted to such an audience as this; yet neither can elementary principles, nor explanatory demonstrations, be excluded or separated. Our object here is to set before you facts which

have been ascertained, and to exhibit to you such proofs of them as this superb Museum affords, of their verity and importance; together with such additional illustrations as we are able occasionally to supply from our own private stores.—At length it occurred to me, that, as in the Surgical part of the Course I intended to treat of those diseases which affect all structures, it would be a proper preliminary step to consider, first of all, the simple structures themselves, as the best preparative for a proper understanding of their disorders, their injuries, and diseases; and, as our anatomical, or rather our ocular, knowledge of most morbid derangements, originates in what we observe of such as arise, or manifest themselves externally, it would be best to commence with the common integument. When I thought I had determined on this plan, after a little reflection, I could scarcely help saying to myself, How?—talk of simple structures, indeed, and begin with the common integument!—Where, in reality, will you find one more complicated, or diversified,

all among the parts of which the human body is composed? But still, however complicated it may be, it is so only from an intertexture, or co-adaptation, of distinguishable substances; and, as far as we can separate them, we must be profited by the careful analysis that resolves them into the simpler materials, which are thus blended, or fitted together.

Indeed, it may be fairly enquired, whether there are *any* simple structures? Is not such a term more calculated to conceal our ignorance, than to manifest our knowledge? Sir Everard Home informs us, that at his request Captain Kater examined the red globules of the blood by a micrometer, and found their average magnitude to be the 5000th part of an inch in diameter; yet each of these globules is in itself a microcosm, comprehending elements, of the abstract nature of which we know but little; of the laws and mode of their combination and arrangement, still less; of their application in the formation or uses of those parts into the substance of which they enter,

but little more; and of their decomposition in the various secretions and ejections, natural and morbid, with which they are combined, least of all. The same may be said of other parts of which the blood consists. The ultimate composition of all the parts of the body may suggest to us a similar remark. Some surfaces present to us an arrangement of vessels disposed in a particular manner; and we find other surfaces in which they seem arranged in the same or a very similar manner, which yet perform very different offices. There is very little apparent difference in the disposition of the vessels of the internal coat of the stomach of a child at birth, and that which may be observed in the skin of the external ear and forehead, at the same period, when minutely injected, and the cuticle is delicately taken off. In other instances, we discover striking differences in their arrangement; but they serve not to explain to us the differences in their products or results. — The conclusion to be drawn from all this, is, that the simplest structures, of which we can take cognizance, are still

highly complicated; that we are in the dark respecting many of their most important attributes; that we can have little or no knowledge, *a priori*, concerning them; that we must patiently and perseveringly study the facts which our faculties are capable of detecting; combine and arrange them to the best of our abilities, and make the most consistent and judicious uses that we can of the whole.

In some cases we can carry our analysis farther than in others; and in most we can carry it far enough to make those useful and necessary distinctions, which will greatly assist our acquisition and communication of theoretical and practical knowledge; and it is an acquaintance with, and conscientious observance of these, by which the scientific practitioner is distinguished from the mere empiric, whose ignorance and disregard of them leave his mind in a state incompetent to that discrimination, without which the employment, and in many instances the success, of his own remedies, will mislead and entangle him.

My intention in making these observations, is not merely to moralize, or to declaim, but to excite and encourage, as far as I can, the industry, the perseverance, the enquiry, the discrimination, and the conscientious feelings of those who are pursuing our laborious science, to full and useful occupation. Young gentlemen, there is much to be done: many, who have gone before you, have done much; but let not this consideration lull *you* into inactivity; let it stimulate you to additional exertions; and let the *examples* of those under whom you have studied be as important in your eyes, as their *instructions*, and as much deserving and demanding your *imitation*, as your *applause*.

In studying the anatomy and physiology of the human body, it is both customary and necessary to examine parts of like structure, and their arrangements, together. First, we may examine the skeleton, the parts which compose the solid machinery, which gives the substantial form and stability to the whole, and on which the softer

and more perishable parts depend for their support, and the due fulfilment of their respective offices. Then we examine the muscles, the organs by which the locomotive powers of the body, and of all its constituent parts, are executed: we look at the system of vessels by which it is nourished and repaired, and to that by which it is modelled and relieved; then to the nervous system, by which it is governed and influenced: then we enquire, how all this fabric is supported. We go from the organs of mastication to those of digestion, secretion, and excretion; then we look to the ultimate objects of the whole, and to those organs by which its final destinations are to be fulfilled. We endeavour to trace the structure and relative uses of the different parts of the organs of sense, and the adaptation and mutual influence of every part, for its share in the purpose of the whole. To understand all these things is our duty, and must therefore be our labour; and to render that labour successful, it must be our pleasure, notwithstanding all the disagreeable circumstances by which it

is unavoidably accompanied.—But we may sometimes reverse this order of procedure with advantage, and investigate the structure of the body by a synthetic, as well as an analytic examination. The latter must, indeed, take the precedence; but the accomplished Surgeon must pursue the former also; for his mind is to go before, and to travel with his knife, through connected parts: he must give no commission to his instrument of which he does not foresee and understand the execution, and, as far as possible, the effect.

Let us return to the point from which we set off; and in proceeding to examine the simplest and most distinguishable structures which we can find, let us begin with an analysis of the common integument; and as my business at present is more with surgical than descriptive, or philosophical anatomy, the reason which has induced me to bring before you a consideration of the skin, leads me necessarily to commence the observations to be made on this substance, by an examination of the cuticle, which

constitutes its most external part; and then to proceed, so that our minds may go, as I have just hinted that our knives must go, from without inward; and thus be more fully and accurately qualified to anticipate and to recognize, when we employ them, what these, our trusty and obedient servants will do, are doing, or may, intentionally or unintentionally, have already done.

I will, however, confess to you my apprehensions, that to some of my audience this subject may, at the first view, appear too superficial and unimportant to merit a deliberate examination in this place, where nothing should be introduced that is not philosophical in its nature, and practical in its tendency. But I am sure that a little consideration will convince you it is both. More than thirty years ago, when I had first made some very successful injections of the common integument, I was forcibly struck, among other important circumstances, with those diversifications of the cuticle, which fit and suit it to the uses of the different parts of the skin, and other

surface which its covers, both by the identity of its substance, and the varied conformation of its structure. I then formed a purpose to pursue the investigation, but the chances and changes of human life and business, had interrupted this, among other plans, till my being called to this situation again excited my attention to it. I then began to regret the paucity of the facts I had ascertained, and of the proofs and documents I had collected. I determined, nevertheless, that I would venture to introduce the subject here, imperfect as the means of illustration within my reach may at present be; for imperfect as they are, they are important, and may be useful, and may lead to farther experiment and observation by others, more capable and more at leisure to carry on the enquiry.

The cuticle seems hitherto to have been too slightly and too superficially noticed by anatomical writers. Yet the cuticle answers some of the most important purposes in the animal economy. All animals are provided with it, in some form or other; and

many have it renewed several times, some indeed, frequently, and periodically, during the course of their life, casting it off at the appointed seasons entire; — so much so, in the case of some insects, and of serpents, as to leave these exuviæ almost in the complete form of the creature which has quitted them. Nor are vegetables destitute of a similar covering. In these, it has been supposed, by M. Mirbel and others, to consist merely of an indurated or desiccated surface of their parenchymatous or alburnous substance; — an opinion altogether without any foundation or analogy; its origin, its growth, and its uses being altogether distinct. It is the protector of the alburnous and parenchymatous substance, and is essential to its attainment of perfection, and to the accomplishment of many purposes carried on within its inclosure; but it has no sensible qualities in common with it, nor is it convertible to similar uses. Indeed, it exists in the germen, before the parenchyma is deposited.

A similar idea has been entertained respecting the human cuticle; but this is refuted by the fact of its existence in the fœtus in utero, from the earliest period; by its proportional increase and approach to perfection, and fitness for its destinations in that situation, where it is coated and protected by a more copious, or more accumulated exudation, or rather secretion, from the sibaceous glands, than takes place after birth, or in the adult body. It is also then surrounded by the liquor amnii, which of itself, and most especially in that state of seclusion from all means of evaporation, effectually prevents the sort and mode of induration supposed, from taking place. It must also be observed, that when the cuticle is abraded, and something like this induration comes on, it is not a cuticle, but a scab, formed by a healing process, (to which I shall hereafter have occasion to advert, and which was first philosophically noticed by Mr. Hunter,) under the protection of which new and real cuticle is actually produced. Morgagni imagined, that the cuticle was originally formed of the surface of the skin,

first hardened by the constant pressure of the liquor amnii itself; and after birth, by that of the atmosphere: a supposition altogether gratuitous, without evidence, or even probability. As well might it be affirmed that the aponeurotic expansion, which covers certain muscles, and sets of muscles, is owing to the pressure of the superjacent parts; instead of forming a definite and distinct allotment in the configuration and purposes of the whole body. It would be an endless task to recount and refute the multiplicities of conjecture and hasty conclusion into which even sensible, but zealous men, have been too often betrayed, concerning the formation, the growth, the functions, and consequently the diseases of parts. Perhaps even the mere mention of them, in this situation, may require an apology. Yet a delicate allusion to them may not be without its use. I mention them with no view to ridicule, nor to triumph. But an indulgence of imagination on subjects of science must always be dangerous to the operations of the mind, except so far as it leads to ex-

periment and observation, and holds the judgment in a modest state of suspense till these shall determine it to authorized conclusions. It is too apt also to lead us off from the due and reverential contemplation, without either superstition or fanaticism, of that Supreme Intelligence from which all other intelligence is derived, and which has framed and ordered all our organs, their formation, their support, their uses, and their repairs, not by promiscous and doubtful, but by concerted, and adequate, and certain operations.—For I may ask, are we even now free from this danger? Do not assumed hypotheses still beset us? Are we yet out of that latitude in which

> " Whim the second reigns, like whim the first.

In no branch of science is it more important than in ours, that we should in all cases take nature simply as we find her; that we should not be in haste to form conclusions, in which accurate observation and correct experiment (which indeed is only one path to observation) will not bear us

out, step by step, without leaping or aberration; for her subtleties can only be penetrated by those who will submit to become her patient, her obedient, her diligent,—and must I not add, who are also her capable servants.

As the cuticle exists in human and other animals, it is called *epidermis*, or a covering for the skin; and so undoubtedly it is. So also it has been called, by vegetable physiologists, in relation to plants, but improperly; for in many parts of these there is no skin for it to invest; and with regard even to animals, the term, though applicable to them in the full import of its meaning, is by no means sufficiently expressive of its extent, still less of its numerous uses. The observations of modern anatomists have shown, that it not only covers the skin, properly so called, but that it is also continued from the boundaries of the skin, over parts accessible to the atmosphere, but where the true characters of skin are entirely lost. It extends over the conjunctiva, the nostrils, the tympanum,

and the mouth, down the œsophagus and trachea, and into the anus, the vagina, and the urethra. Haller says, "I have known no part of the human body which could be exposed to the air with impunity, except the cuticle, and the enamel of the teeth." Such, he observes, is the dryness or the acrimony of the air, that the naked skin can never remain in contact with it. This element changes the nerves, and even the tendons, into hard, pellucid, and fragile cords. The bones, when denuded and subjected to its immediate access, quickly die, and afterwards exfoliate their suffering surfaces, or throw out granulation from those surfaces to supply its place: but the cuticle supports it, without injury or decay; and appears immutable under its influence, in all variations of climate and temperature in the habitable world. And though the sudden application of excessive heat or cold frequently occasions it to fall off, we may learn from the experiments of Dr. G. Fordyce and Sir C. Blagden in the heated rooms, and from the accounts of voyagers to the polar regions, that this is not so

much, in either extreme, from the destructible nature of the cuticle itself by these agents, in ordinary cases, as from the suddenness and excess with which their influences are exerted on the organization underneath it, from which it is nourished. Where, indeed, it is continued from the true cutis, over the serous and mucous membranes, its extreme thinness causes it to elude general and distinct observation, not instituted with a careful and express view to its detection. It is nevertheless capable of demonstration, and being moistened continually by fluids secreted for that purpose, is preserved in a state capable of affording a mild, but effectual protection, to those delicate and sensible parts, from which the privation of it is always severely felt, and felt to be an injury. It enables them to perform their fine functions in peace and with regularity ; and is so constructed, and so applied to them, that, though insensible itself, it preserves both their common and peculiar sensibilities in perfection, in harmony, and in ease. It guards against dangers from within the

body, and from without. The minutest breach in it often affords an introduction to the most malignant and deadly poisons, from the influence of which, by its perfect and complete integrity, the body would have been securely defended. There is no single substance more uniform in its composition, or more diversified in the arrangement of its parts, on the various surfaces it is appointed to cover and protect. We are still very deficient as to an exact knowledge of the peculiarities of its chemical composition; and deeply do I regret this deficiency, and that my own want of acquaintance with practical and experimental chemistry has left me unable to supply it. Mr. Hatchett found it to consist chiefly of gelatine; but so do other parts, of very different texture and uses. Sir Humphrey Davy found silex to form a part of the cuticle of vegetables; and it may be worth while for some examinations to be made, in order to ascertain whether it does not form a part of that of animals also; thus clothing both, as it were, with a flinty coat of mail, for their perpetual protection against ordinary

dangers. Perhaps no substance can be named more distinctly in proof and illustration of the doctrine of final causes, or of the original and omniscient adaptation of apparently simple means, to complicated and important ends. It is the most unputrescible of all the soft parts of the body: it is the great medium of intervention and defence between the active living solid, and the decomposing powers by which it is surrounded. Its structure, and its preventive properties and influences, remain long after death; and were it not for this permanence, the skins of animals, which are convertible into so many uses, for civil and commercial purposes in society, would not be sufficiently tenacious of their textures, when dead, to be preserved for those uses. Such, indeed, and so effectual are the preservative powers of this seemingly insignificant and simple substance, that we see in the mummies that are brought to us from Egypt, that it was the practice of that people, in the process of embalming, previously to take off the cuticle from the body, in order to enable it to imbibe the

bituminous substance, by which it was to be defended from putrescency; and that in all those parts, or patches, where the cuticle has escaped from a removal, the impregnation by the bitumen has not properly taken place, the places underneath *these* appearing to owe their continuance entirely to a communication of the preserving power of the substance entering into those which adjoin them, or are attached to them. Unbroken vesications, which remain after death, or are produced subsequently by transudation, will retain their fulness for many days, if the cuticle remain perfectly entire; while, if it be ruptured, or penetrated, desiccation of the cutis will speedily ensue. All the functions of the cutis are performed and prepared through its intervention, with their requisite distinctness and accuracy: — Tact, in all its gradations; temperature, in its different influences and changes; absorption and exclusion, in their numberless variations, and under an infinite diversity of circumstances; perspiration, in all its degrees, and with all its modifications, take place through its well-fitted and

appropriate structure; not merely by the promiscuous or accidental accretions of material particles or properties, but by a regular and perfect construction, arising out of, and subjected to the domination of the principle of life, and constituting a large and distinctly organized expansion. The bulbs, the hairs, the sebaceous glands, and the nails, which, indeed, may be considered as a production or modification of it, in a more concrete form, are all kept by it in their proper situations and offices. It gives the finish to that delicate beauty of complexion in our race, which charms us when we behold it, and which its abrasion would immediately impair or destroy. As Sir James Smith has well and beautifully observed, "both in animals and vegetables, it forms a fine but essential barrier between life and destruction." It is constantly in a state of perpetual, and, as it were, vegetative growth and decay; its exterior surface dying off in furfuraceous scales or patches, or minuter particles, which demand constant ablution, in order that the interior and essential may be preserved in a state of competence to

assist and promote the regular performance of the functions of the parts which it invests and protects. Leeuwenhoek imagined that these scales were a part of its necessary and original structure, and were therefore analagous to the scales of fish; but in this opinion he erred; the scaly appearance belonging only to the effete exterior surface, which has become unfit for use, and is therefore detached from the essential part in this gradual and imperceptible manner, as it requires removal, when the interior portion is renovated. Its growth and nourishment are adapted, in all the places it covers, to their exigencies, so as to render the fulfilment of its offices perfect in them all; and it is therefore found in all gradations, from its delicate softness on the female lip, to its thickness on the hand of the laborious mechanic, and on the foot of the hardy ploughman. Its wonderful tenuity, in some instances, rendering it liable to excoriation from very trifling causes; and its thickness and hardness in others, giving rise to some of the most painful and insufferable symptoms of disease

in the parts underneath it. It clothes countless millions of papillæ, and countless millions of transpiring and absorbing vessels which are placed in a surprizing variety of arrangements, to carry on, to harmonize, protect, and perfect the functions of the skin, and the numerous parts of which that complicated and most important organ is made up, and with which it is studded over in innumerable points. Indeed, without a proper contemplation of it, we shall not be able thoroughly to enter into the anatomy, physiology, or pathology of the cutis itself, or understand the nature and remedies of those diseases which arise from, or accompany a breach in its structure, or an interruption of the fulfilment of its purposes.

The cuticle appears to be nourished by some vessels ramifying on the cutis, and appropriated chiefly to this purpose. These vessels, when stimulated, either by pressure, friction, or the application of certain irritating substances, are soon excited to secrete

a serous fluid underneath it, by which it is speedily, and sometimes very suddenly, as in scalds, loosened from the surfaces with which it was in contact; and in consequence of this separation it dies, and peels off. In this state of detachment, the fluid underneath does not transude through it in any thing like the proportion of the perspiration which would have been transmitted by it, had it remained in its natural situation and condition; as if its interior fabric was shut up by maceration in the secreted fluid; but affording, at the same time, an additional proof of the protecting power of the substance itself. It is, however, in all instances ultimately destroyed, in consequence of the separation. In some, it bursts from the rapidity with which the secretion of the serous fluid under it takes place, and its own thinness and delicacy. In others, it retains its continuity for days together, serving then the mere subordinate office of defending the cutis from farther mischief, till its place has been supplied by a new formation of a substance like itself. Then it dries and exfoliates, unless previously

removed; but not with absolute impunity to the tender and irritated surface it has quitted; which generally, by an itching or tingling sensation, gives notice of the change it has passed through. Finally, however, this ceases, unless the state of the constitution be unhealthy, or the part in other respects unsound, and things resume their former and ordinary course. And even when the injury is deeper, nay, when large portions of substance are destroyed or extirpated, as after amputation, for example, it is still in process of time renewed, to cover every outer surface which has been exposed; and like a faithful guardian spreads its defending influence over its supporter, which is at the same time its dependant—the new and regenerated skin.

The cuticle, however, which is found on the surface of the new skin, for a considerable time, and in some cases always, proves itself inferior in its properties to that which covers the skin which formed a part of the natural surface of the body, as it is originally constructed. It often cracks, and

sooner dries. It is more liable to abrasion, and more slowly renewed when abraded or blistered; and although it serves for its principal destined uses, this is in a more limited degree. Atmospheric changes are often perceived through it more sensibly, but sometimes more slowly; though both these circumstances are at length less felt if the patient be young, than if he have attained full maturity, or be advancing toward old age, when the evil occurs.

In, and after many diseases it is cast off, sometimes in smaller and sometimes in larger pieces. In the latter, the scaly appearance is not visible; neither is it when taken from a dead body by the affusion of boiling water. The late Mr. George Wilson, a respectable apothecary in Bedford Street,—(whose incessant wit and humour some of us recollect to have enlivened many a dull evening's discussion), for several years successively, exhibited at the Lyceum Medicum Londinense, from a patient who was subject to annual attacks of erysipelas, the cuticle of the hand cast off entire in the form

of a glove; and from the foot, as a complete sack. A case somewhat similar is recorded in the sixtieth volume of the Philosophical Transactions. Such instances are, I believe, very rare; but the thickness and substance of the cuticle on the hands and feet render them more likely to occur in these parts than any where else on the body. This difference is found to exist in the cuticle of the fœtus before birth, so as to show its preparatory and intended adaptation to the uses of these parts. Indeed, so great is its thickness and compactness in some instances as to support the heat of burning bodies for a considerable time with comparative impunity; as in the cases of the smiths at Leyden, recorded by Boerhaave; of the glass manufacturers at Basle, which Haller says he witnessed himself; of the inhabitants of some volcanic countries; and of those wonder-workers, who sometimes exhibit themselves and their feats in large towns, and at fairs. Curious exemplifications, however, do these feats afford of the power with which the body is endowed, to adapt itself to conditions and circumstances, which,

a priori, we might naturally enough suppose would be totally inconsistent with its health and integrity.

The cuticle, being thus devoid of sensibility, has been considered as not a living substance. But I think a little reflection will show that this opinion has been too hastily formed. For we do not know of any instance in which parts that are in no respect living, can be closely attached to those which are so, without an obvious, definite, and irreconcilable difference; a difference which always tends to a final and perpetual separation between one and the other, or to involve both in mutual destruction. The vital powers of the cuticle are indeed comparatively feeble; although it undergoes a more gradual, regular, and unvarying transition from life and usefulness to decay, than any other part. But this transition may be hastened by the application to it of a variety of substances while connected with the living body, which have no similar influence upon it when life has ceased. When by the influence of any of

these agents, or of others, its surface becomes unfit to correspond with the rest, the more living parts which it covers take the alarm, and it speedily becomes easily separable from that which remains perfect. Its too hasty detachment, as in many cutaneous affections; or its more reluctant separation, as in corns, is always to be considered as a morbid state of it; and if the fault should lie in the vessels which nourish it, the same is the fact with regard to other parts, the vitality of which cannot be disputed.

In every instance, in a state of health, this substance has a perfect conformity to the organic structure of the true skin, of which it is at once the faithful servant, and the indispensable guardian: so that in order thoroughly to take cognizance of it, in this point of consideration, the anatomy of the cutis itself must be previously known. We may, however, with the assistance of magnifying-glasses, see much variety on its outer surface, in the different appearances it presents to us as it covers the eye, the

scalp, the forehead, the cheeks, the nose, the lips, the trunk of the body generally, the scrotum and organs of generation, the fingers, the palms of the hands, the legs, the arms, the soles of the feet, the toes, and the heels. Varieties which are original, and not adventitious; the original texture being evidently intended, however, to make provision for the occasional production and security of the adventitious, when, and so long as it may be needed.

It therefore follows many morbid changes in the true skin, as it is called, by corresponding changes in its own condition and growth, as certainly as in those which arise from natural habits and occupations; although in morbid processes it often becomes diseased, as well as the cutis itself. Sometimes being partially deficient; too thin, or too thick, or connected with unsightly and distressing incrustations or desquamations. So that, from an accurate inspection of it, we may be enabled more fully to judge of the state of the subjacent skin.

For the skin is as dependent on the cuticle as the cuticle is on the skin, for the perfection of its structure and the performance of its functions. Neither can subsist in a state of integrity, without that of the other; and therefore provision is made up to a certain degree, for the regeneration and concomitance of both together; not only under natural, but also under novel and artificial circumstances. A coincidence which may be seen in many diseases, in a very remarkable degree, accompanied also by the reproduction of what has been called the rete mucosum, but which ought to be rather named the second, or interior epidermis, though both are sometimes imperfect, and sometimes appear to be redundant; especially the cuticle, which therefore more frequently for some time exfoliates, after it has invested sores recently healed, than when it covers original surfaces; the vessels which nourish it being in such cases partly destroyed, and therefore more scanty and more feeble; and their products of course more deficient,

both with respect to formation, and to vital energy.

Inadequate as my own examinations have hitherto been, I have nevertheless contemplated with admiration and surprize the variegated appearances and adaptations of the cuticle, to which I have already alluded. Let us begin with the hand, as the part most ready for the inspection of any individual in himself, and which on that account, probably, has more attracted the attention of observers than any other. Here, however, are many diversities of configuration and adjustment, in order to suit it to the perpetually changing duties of the parts it covers, without interrupting the two grand purposes of unceasing protection, and of transpiration, which are going on during all healthy actions, and even withstand, and persevere during many which are violent and unhealthy. How else could many of the arts and manufactures, by which life and society are comforted and enriched, be carried on with impunity? How else could the waterman and the

sailor ply their oars and reef and un-reef their sails; how could the scavenger, the half-scorched glass-melter, the dusty miller, the half-buried miner, and the perilous labourer in lead and arsenic, sustain their duties, without more materially interrupting these uses of the cuticle, than the tender sempstress, or the watchmaker? To all these conditions, and others, is this material fitted, for its relative services, in the grasp of the sturdy feller of timber, the fine and delicate touch of a Raphael or a Guido; of a Handel, a Haydn, and a Mozart.

In the fourth plate of Bidloo's great work, De Lairesse, under the direction of that anatomist, has represented the appearances of the skin, covered with cuticle, as it is to be seen on the hand; and particularly on the thumb, on the ball and the back of which, two of its most striking and ostensible variations are visible. The representations are far from being perfect; especially as they only show the exterior surface, and not the interior conformation.

They are, however, obvious, and may serve us in the first step to an illustration of this part of our subject. On the ends of the fingers and toes and on the ball of the thumb, and on the under part of the heels, it presents a curvilinear appearance; whereas in other parts it is arranged in rugæ in various directions; longitudinal, transverse, and angular. (See Plate I. fig. 1, 2.) In the former, where the nails are inserted into it, it is evidently intended to preserve that degree of tenseness in the subjacent skin, which is essential to the nicest exactitude and delicacy of the organ of touch; being stretched over the cutis, from one side of the nail to the other, somewhat as the skin of a drum is from its frame. So essential is this circumstance, that we find in cases of paronychia, where the nail is lost for a time, the sensation of touch is materially impaired; being either benumbed, or attended with pain, but in both cases comparatively uninstructive; till the regeneration of the nail is sufficiently advanced to restore the cu-

ticle of the affected part to its requisite firmness and stability.

The rugæ which appear in other parts of the cuticular surface are adapted to the greater mobility of which it is to admit, and to provide against the infinitely varied flexures, that the uses of the parts it invests necessarily demand; and they mark out lines, at which a kind of ligamentous structure descends to the coriaceous part of the skin, and which keeps the whole organ steady, during these changes, without rigidity; and admits of yielding and softness, without the risk of laceration. (See Plate I. fig. 3.)

But how is the office of perspiration carried on through the cuticle? What and where are its pores, which have been supposed to transmit this fine exhalation? Are there any in reality? If there be, how are we to account for the fact before alluded to, that the cuticle does not admit of the evaporation of the fluid secreted in a vesication, but generally serves rather to

prevent it, till the formation of a new surface, of the same kind with itself, is considerably advanced? And if there be no such pores, by what contrivance is it that a function of such indispensable importance to the animal economy, and an evacuation so large in its amount, and unceasing in its secretion, is maintained, with such constancy and regularity? How is it that the fluid of a miliary eruption is detained, when the excessive perspiration which induced it has ceased? How is it also that petechiæ remain, the extravasated blood being usually absorbed, and not discharged, and this so completely, that the vessels which have given way heal, and a fresh cuticle invests them, before that which covered the spot is detached? How is it also, that various materials pass through it from without, so as to combine with the general mass of blood, and produce their own distinct and recognizable effects?

Pressed by this difficulty, I began an examination of both surfaces of the cuticle, the exterior and the interior. I recollected

that they are adapted to different circumstances: the outer being exposed to the atmosphere, and being destined for protection; the inner being adapted, in conjunction with what has been very improperly called the rete mucosum, to invest and assist the fine vascular texture of the cutis, by which the function we are considering is carried on. It seemed highly probable, therefore, that the two surfaces had each its peculiar arrangement, to correspond with its distinct and peculiar purposes. That which is external is, for the most part, comparatively smooth and glossy; the internal is materially different. I took some portions of cuticle from various parts of the body, and laid it in the field of a microscope, magnifying 140 times, with some glazed dark blue paper under it, hoping to detect the pores, by the coloured paper appearing through them; but I could find none that could be properly called by that name, except where it was evident it had been perforated by small hairs, which it had quitted. Instead of pores, I found an infinite number of minute velamina, re-

gularly arranged, of exquisite tenuity, presenting a follicular appearance, and separated from each other by bands of a thicker substance, crossing and intersecting them, so as to render them distinct, as represented in the drawings, which have been made by my son, who, in addition to his being a minute and accurate anatomist, is able exactly and faithfully to delineate what may come under his observation. (See figs. 1, 2, 3, 4, and 5. Plate II.)

The mystery now appeared approaching to a solution ; for if the terminal vessels of the cutaneous apparatus, of which I shall have more to say in a subsequent lecture, are lodged, as I fully believe them to be, in these velamina, (of which, though perfectly distinct, I attempted in vain to count the number in the fortieth part of a square inch,) so long as the vessels maintain a vital connection with them, they transmit their secretion through them, as through a bibulous, and exquisitely hygrometrical covering, of the finest delicacy and perfection ; while, through the same medium,

and dependent on subjacent tubes taking a contrary course inward, absorption is carried on to a great, but less certain extent and continuity. The whole purpose which could be answered by pores, or holes, as the term is commonly understood, is thus fulfilled by an arrangement, which, while it answers all the purposes, avoids all the inconveniences of perforatory pores, as it obviates all chance of extravasation within, of hurtful exposure without, and of confusion in either direction. But when this vital union is destroyed, the cuticle, now reduced to its merely chemical but astonishing properties of endurance, becomes incapable of continuing its transmissive office with any certainty or regularity. It is macerated, as it were, in the subjacent exudation, or impaired and broken through by the too active exertions of the vessels which formerly nourished and supported it; so as to loosen and detach itself, in pieces of various size, from fine powdery and furfuraceous scales, or portions, to large desquamations, and even to the entire covering it has given to a hand or a foot.

Nor is the structure I have been describing without an analogy in the body; the inhalation and exhalation which are constantly going on in the air-cells of the lungs, appearing to take place in a manner almost or precisely similar.

We may also hence see the reasons why vesications on hairy parts, as the scalp, for instance, do not retain the fluid effused so long as others; for when the cuticle is separated from the hairs, the fluid readily escapes by the perforations they leave through it, which in consequence sooner lacerates, and breaks away.

If I am not mistaken, this developement of the structure and properties of the cuticle, with what I shall hereafter bring before you concerning the rest of the integuments, opens a new field of important enquiry; and, as I expect to show, when I endeavour to sum up its practical conclusions and uses, or at least that comparatively small part of them which has, as yet, fallen under my observation, tends to throw

light on the nature and influence of many cutaneous diseases, and may probably help us hereafter in finding out a more scientific, and curative, or alleviating management of them, than we could otherwise have attained. And I am inclined to believe, that to an unacquaintedness with these facts, we are to ascribe that unwelcome and disappointing pause, which has for so many years continued, in the investigation of the physiology and the scientific pathology of the skin, both under its idiopathic and symptomatic derangements.

LECTURE V.

March 27.

To the natural history of the cuticle has generally been thought to belong that of the nails and hair; the latter I think incorrectly, for they are more connected with the cutis; but the former justly, as they form a continuous covering with it for the skin, at the superior surfaces of the ends of the fingers and toes. They are not, however, an identity of substance, although under chemical analysis they yield the same, or nearly the same, products. In a variety of diseases they are readily detached from it; though in a natural state they are inserted into it, strongly adhering to it, and often come away with it by maceration, or the action of boiling water. In the exuviæ of insects also, the nails separate with the

cuticle. Their roots are surmounted and enclosed by a semilunar projection of the cutis, over which the cuticle extends, and also grows up beyond it. In man, and some other animals, they are thin and flattened; in other animals, thick and conical, without sensibility, and without vessels. They much resemble horn, and in some cases are converted into horn, especially on the great toe; from whence I have repeatedly had occasion to remove them by a saw, on account of the great inconvenience and pain produced by their length and curvature. In some cases, however, I have seen a contrary departure from their natural condition; when, in consequence of a debilitated state of the circulation in the extremities, they have become much shorter than they ought to be, the last bony phalanx appearing to partake in this degeneracy. They are placed on the surface of extension; but if left to grow far beyond the ends of the fingers or toes, they curve toward the surface of flexion. They appear composed of horny fibres, which grow firmly compacted together in a

longitudinal direction, from a highly vascular tissue at their roots, where they are soft and flexible; and if split by violence in this direction down to the root, the mark of the fissure remains through life, unless the whole of the nail so split should be cast off. If broken in a transverse direction, no such permanent deformity follows. They are not perforated by pores, either for hairs or sebaceous glands; nor do they sustain any part in the transpiratory function; nor are they endued with any power of contraction or relaxation. They are thinnest and softest at their connection with the cuticle, and increase in thickness, hardness, and often in breadth and in brittleness, till they have quitted it, near to the termination of the extreme phalanx. In man they are more fitted to be instruments for use than for defence. Their substance, arched form, their shape, situation, and insertion into the cuticle, give greater firmness and accuracy to the sense of touch at the ends of the fingers, without endangering the apparatus adapted to this purpose, by the requisite degrees of pressure. The interior epidermis

is not continued under them. Being bad conductors of heat, they probably also are greatly useful in preserving and recovering the proper and necessary warmth of these delicate parts, during and after their exposure to many gradations of temperature above and below their own, on the different surfaces with which they are brought into contact. They asist us in an infinite variety of manual operations, and protect the termination of the bone which supports them. They do not, however, depend upon the bone, but upon the skin, for their supplies and continued progression ; and if their roots, or any part of their roots, be left in the skin, in such proportion may their substance go on to grow, although the bone which was originally underneath them be lost. But in this case they become deformed ; their curvature toward the line of flexion is more abrupt, and genenerally so much so as to render them not only useless, but inconvenient. Their firm texture, and close attachment to the surfaces they cover, render injuries and inflammatory affections of those surfaces, and

excrescences, which sometimes grow under them, almost intolerably painful; and have furnished a cruel source to savages and persecutors for the horrid and barbarous tortures which the former have inflicted on their captives, and which the latter have not scrupled to employ, in their vain and infuriated attempts to violate reason, and abolish the honest profession of truth. Under inflammation and its consequences a whole nail is not unfrequently detached at once; but if the vascular surface from which it grew is not also destroyed, the loss is gradually repaired, by the regeneration of a new nail, which commonly, though not always, is as perfect and as fitted for its uses as the former, if the cutaneous vessels at its root, from which it is nourished, are not materially injured by the disease, or the violence, which has occasioned its separation.

I have just intimated that the ordinary association of the hair with the description of the cuticle appears to me to be somewhat incorrect; not only because their

offices are quite distinct, but because the hairs merely permeate the cuticle; they do not grow from it, nor are they essential to it. They grow from bulbs, which have their seat on the coriaceous part of the skin, and are nourished by vessels presently to be described. It is the removal of these bulbs, however, when the cuticle is detached by maceration, which gives to the skin most of that appearance of pores, or holes, which has, and naturally enough, misled anatomists who have examined this organ. Of these there are millions on the surface of the body, if we include among them, as we ought, the lodgements of the bulbs or roots of that congeries of capilluli, which compose the delicate pubescence, that gives the finished softness to infantile and feminine beauty. This porous appearance of the skin is still more remarkable, if the sebaceous glands be also detached from it, the ducts of which also open through the cuticle on its external surface. But neither are these, nor the hairs, nor the pores in which they are fixed, much, if at all, concerned in the office of perspiration.

I shall, therefore, for a moment, defer a more minute attention to them, and proceed with the examination of the integuments on the plan I first proposed, going from without, inward.

Immediately, then, underneath the cuticle, you know, gentlemen, there is situated another membranous substance, which has been called the Rete Mucosum: improperly so called, however; for it is neither a network-like membrane, nor is it a mucous substance; except in so far as it is sooner soluble by maceration, and, when putrescent, exhibits the appearance of a slimy matter; not coherent like mucus, but more diffusible, and more easily washed away than either the cuticle or cutis. It has been by some considered as a lamina of the cuticle itself; but it is no such thing; being altogether different in its ostensible properties, and intended and adapted for very different uses. It should rather be called the second, or interior Epidermis, for reasons I shall presently explain. It varies much in its colour in the natives of dif-

ferent countries, from the fair Circassian to the dusky Negro; and considerable variety is also evident in persons of different temperaments, inhabiting the same climate, and exposed to similar circumstances of parentage and habit. It is in general readily separable, with due care, from the cuticle. It is much more equable in its thickness, softer in its composition, and seems placed as a more certain, yielding, and delicate intermedium between the variable and insensible cuticle itself, and the vascular and nervous and sensible substance of the true cutis. In consequence of this, it serves at once duly to graduate and preserve the sensibilities of the cutis, and to secure the regular and appropriate performance of its numerous functions. Its black colour in the Negro was long supposed, and by the recent experiments and observations of Sir Everard Home is now fully proved, to be a great mean of the preservation of the cutis from the injurious effects of a tropical sun. But its preservative effects are not limited to the Negro. It is in itself a bad conductor of heat; and, being placed imme-

diately under another bad conductor, and over a quick one, it must materially contribute to the uniformity of temperature, so necessary to an animal destined to inhabit all climates, and to rule in them all. It does not seem to be exactly co-extensive with the cuticle; but of this I am not sure: the extreme fineness of the cuticle in some parts, as over the conjunctiva, causing it, if it does exist, to be too slender for detection, unless under very fortunate and uncontroulable circumstances, which accident only is likely to present. It appears therefore to be chiefly, if not altogether, confined to those parts which may be in danger of suffering, under the want of other organic protection, from exposure to compression, or to excessive heat, or extreme cold. When the papillæ of the skin, which we are by and by to examine, become elongated by diseased growth, they attain a considerable length, before either this or the cuticle break, or become perforated by them. Both are elongated with them, not indefinitely, but nevertheless to a very remarkable degree, serving thus as an investiture, or exact clothing, to each indi-

vidually, as well as to all collectively. When the cutis itself has been destroyed, by injury or disease, it may be partially, but only partially, regenerated; probably at least not so completely as the cuticle; and this, perhaps, may be one considerable reason of cicatrices being more painful at certain times, especially under atmospheric changes, than the original skin; for we can hardly suppose that the nerves of the new skin can be more perfect than those of the first; indeed, we know that their sensations are not in general so accurate and instructive. It has been asserted that it is never reproduced,—an opinion which has rested chiefly on the paleness of the cicatrices of Negroes; but this notion is incorrect; and many cicatrices of Negroes are black, though less black than the surrounding skin, as may be seen in those who have recovered from confluent small-pox; much of the restorative process, in all these cases, depending on the greater or less depth and extent, to which the blood-vessels supplying the parts affected have been injured or destroyed. I have

been somewhat surprised to find an anatomist, generally so discriminating as Bichat, speak so loosely and undeterminately concerning this substance, which he seems strangely to confound with the vascular apparatus underneath, on the surface of the corium of the cutis. He calls it a general capillary system, which forms with the papillæ an intermediate layer (*une couche intermediaire*) betwixt the corium and the epidermis ; and adds, that it contains, in the greater part of the human race, only white fluids, but black fluids in the Negro. He thought he had injected it ; and yet he says there is no circulation going on in it ;—a confusion of ideas that must have arisen from his not having sufficiently distinguished it from the vascular structure, from which it is entirely separate and distinct, though deriving, of course, its nourishment from thence. I have never succeeded so far as to force any thing into it, even when I have filled the cutaneous vessels to the most perfect minuteness. Nor do I believe that any more satisfactory account can be given of the cause of the

blackness of it in the Negro, or of its paleness in the European, than of the yellowness of the bile in most animals, and of its vivid greenness in others, as in the turtle. It is a product depending wholly on the principle and operations of life. In the areola of the nipples of pregnant and suckling women, we often find it black; but only for the time those processes are going on, and then resuming its former appearance. Haller tells us he once saw it on the pubis of a woman as black as the skin of an Æthiopian; and on the faces and hands of persons exposed, in an unaccustomed degree, to the rays of the sun and to the sea-breezes, it is often found to change its tint for a while, and afterward to be as it was before. We need not depart in our speculations concerning it from simple and obvious facts. Its general uses I have already stated, and that it assumes varieties to answer other purposes, when they become necessary. It affords a soft nidus for the vascular and nervous structures of the complicated organ which it invests, both under pressure, and exposure to changes of tem-

perature. It adds to the smoothness, softness, beauty, and delicacy of that organ; preserving its sensibilities, and the balance of the circulation in its extreme vessels, with more perfect precision than could be secured without it. The privation of it from any part of the surface it ought to cover, is always followed by considerable inconvenience; and often occasions a necessity for the suppurative process to secure its restoration, when the detachment of the cuticle alone, could be repaired by means of greater simplicity, in a manner less expensive to the constitutional powers, and occasioning less suffering to the patient. In some instances, however, its loss seems to be almost immediately atoned for by the effusion of a protecting stratum of coagulable lymph. The various degrees of intensity with which blisters act, show all these circumstances, and often demand our vigilance in the employment of them, lest we err on the side of severity; especially in children, and persons of delicate constitutions, on whom they should not, in general, be allowed to remain longer than is suf-

ficient to elevate the external epidermis. If the interior be also separated, especially if the blistered surface be extensive, it is no uncommon thing for the vascular, and even the coriaceous surface of the cutis itself to slough. — I have seen many lives lost from this occurrence; particularly where the constitution had been previously much weakened, either by large bleedings, or the influence of acute and severe disease: and though the effusion of a stratum of the coagulable lymph does sometimes appear to stop this mischief, it does not so always; the stratum itself first assuming an irregular honeycomb-like surface, which is usually a prelude or an accompaniment to deeper gangrene, and indicates a perilous failure of vigour in the vital powers.

It may be remarked, further, that the interior epidermis is more closely connected with the sebaceous glands than the cuticle. I shall by and by have to notice these glands more particularly; but it is to my present purpose to observe, that the exterior epidermis, when carefully detached from

the interior by due maceration, does not bring the ordinary sebaceous glands away with it; but the interior does. And this shows that the cutaneous function must inevitably suffer greater derangement when this circumstance takes place than when it does not; that our endeavours in blistering should usually be confined to an excitement of the vessels which nourish these parts, and not be extended to the destruction of any thing more than is easily reparable; namely, of the cuticle itself, for the restoration of which more ample resources exist in the constitutional energies and arrangements; and that, in consequence, where long excitement and counter-irritation appear to be indicated, it is better to seek it by issues of some description; especially by setons, or discharges produced in interstitial incisions or spaces, than by what have been called perpetual blisters, or other methods which endanger a destruction of the whole, or important part, of the cutaneous apparatus. This, as I have intimated, will require especial attention in the cases of infants, whose thin cuticle, and

tender, and irritable, and active skin, expose them to much greater disadvantage even than adults; because the period of growth, which is the extension of the corporeal fabric, demands in them a more uniform exercise and perfection of the actions which go on upon its surface.

LECTURE VI.

MARCH 29.

HAVING thus far considered the epidermal parts of the common integument, I now wish to take a somewhat minute view of that fine vascular and nervous fabric underneath them, which, spread out over the coriaceous part of the skin that protects them from within, and defended by the substances already described from without, and assisted by both, sustains its most vital and essential offices. In attempting this, I shall not affect to conceal that I have derived many indications and much assistance from the labours of others who have gone before me; but as their means of investigation were inferior to those we now possess, their observations necessarily partake of this imperfection; and account

for many of their remarks being partial, and comparatively unconnected, and in numerous instances disjointed by the interpolations of conjecture. If, therefore, I do not quote them by name, it is because I apprehend this would rather confuse than elucidate the subject; and because I shall feel more at liberty, having enjoyed such advantages, and having endeavoured to fill up some of the deficiencies that have been left, if I give a direct statement of what I have observed; and of what I have, so far as I have already gone, perceived to be worthy of farther investigation, in giving a simple detail of facts, than by enumerating authors, the mere recital of whose names and experiments might, in many instances, even obscure the distinctness and value of that which they have recorded. We must all ascend, at first, upon the preparatory labours of those who have preceded us; neither undervaluing them, nor resting perfectly satisfied in unobservance or inaction. While we follow with gratitude, let us imitate with ardour; but at the same time with that humble and circumspect consideration

and caution, which will suggest to us, that those who are to come after us may probably have to point out and to remedy oversights and omissions of our own, similar to those which have escaped our predecessors; but which do not, in any essential respect, diminish the importance of their labours, or justify a censorious spirit. Even errors, whether of our own or of others, may not unfrequently lead to instruction, if they excite more strict and accurate enquiry.

Let us now recall the essential functions for which the skin is designed, and then consider with what infinite minuteness and wisdom it is constructed to answer them. It is an extensive range of surface, and, at the same time, a test, a sort of gauge, or meter, of the correctness and healthfulness of the circulation of the general mass of the nutritious fluid: and therefore, in turn, of the departures of that circulation from its just proportions, its moderation, or its strength. It is an organ of transpiration, by which various materials, the retention of

which would disturb the whole animal economy, are discharged in combination, in an almost imperceptible, or at least an unconscious manner, and in a gaseous form. It is a medium of absorption, through which poisons and remedies are both conveyed; and it is an organ of sensation, of which the minutest point may be so touched or affected as to produce the most pleasing or the most painful impressions. Lax, and soft, and delicate, and beautiful, as it seems, and as it really is, it is equal to the finest stretched monochord; of which no division can be struck, independent of the whole, either in actual feeling, or actual influence. An insect scarcely visible, as the *furia infernalis* of Lapland, may distract its victim almost to madness; while the huntsman endures the succussions and the toils of the chace, not only with impunity, but with delight. And may we not also notice, with pleasure and admiration, the beauty that in the human race, and the human race alone, affords that continual and almost inexhaustible source of gratification, which we derive from the con-

templation of juvenile and female beauty; and its harmony with the stronger and bolder features, in which the masculine lines and sturdier characters of the hardier sex, is almost invariably and visibly stamped?

I begin with the office, or rather, I should perhaps say, the *state* of the skin in the *circulatory* system, and its adaptation to that purpose. The perfection of any mechanism for the conveyance of a fluid, let us take even a common watering-pot, depends as much on the due conformation of its ultimate arrangements, as on the form and force in which its power is lodged.— And here I must observe that, in order to gain a better understanding of this subject, I have found it useful, and not only useful, but absolutely necessary, to trace the cutaneous circulation through all its stages and gradations, which are more and more essentially variegated than may at first be imagined. I have therefore derived assistance from very imperfect as well as from more minute injections; each serving, as it were, as a measure of the graduations

and stages of the natural and perfect instrument in question.

My plan, I have told you, was to go from without, inward; and I see no reason to depart from it in this instance. It may not be so methodical as might be expected; but I trust it will not be less practically useful. At all events, I hazard it, with a glimmering and pleasing anticipation, that some who are more capable, and better informed, will hereafter do more justice to this important subject.

All the vascular surface of the skin is minutely penicillated or villous,— a fact which I had made out many years ago, but considered it rather more as curious and beautiful than as important, till I recently discovered that velaminous structure of the cuticle, which I showed to you at our last lecture, and the conformity of the interior epidermis with it; for in the cuticular laminæ, thus lined and assisted, the penicilli, or villi, terminate, or are imbedded, and carry on their ultimate duties. The villi observable in the lips, and at the ends of

the fingers, have been noticed by many anatomists, but have been considered chiefly as instrumental to the peculiar and more delicate sensibilities of those parts. So, indeed, they are; but they arise out of, and are in fact an extension of, the general formation, for particular uses, rather than a departure from it. Successful injections, which are difficult, frustrated often by slight causes, and generally, after all our care and attention, found only in patches, are nevertheless sufficient to verify the fact. (See the plate.)

This structure is supported underneath by a perfect net-work, of more obvious construction, and of more easy detection; which, though so minute as to be seldom recognizable distinctly by the naked eye, is in reality composed of numerous trunks of vessels, for the regular supply of the ultimate arrangement. Of these, the anastomoses are innumerable: the plan is perfect. The disturbance of one part of this highly organic surface is, in a state of regular health, instantly supplied by the

coadjutorship of that in its immediate vicinity; so as not greatly, or long, to interrupt the discharge of its functions. All this fine and well-guarded apparatus is spread upon the corium, and may be compared to the colours of the skilful painter, blended upon his canvass, which at once not only manifests their combination, but secures the final effect of their requisite proportions. This net-work is supplied by larger vessels underneath, which, at acute angles of various degrees, permeate the corium, after having partially ramified underneath it; then subdividing, so as thus to secure, as far as the requisite tenuity of the structure will allow, the regularity of the circulation, and the accurate fulfilment of those other functions, which are made to be dependent upon it. (See the plate.)

I am not prepared to state, by any calculation, how large a proportion of the blood may be computed to be continually flowing over the cutaneous surface. It must, however, be considerable, as may be evident,

not only from the contemplation of the extent of that surface, but from the effect of injuries to the cutis alone, where the vigour of the constitution is on the decline. I have known a person nearly bleed to death, from a few orifices left after a very superficial cupping. Undoubtedly in this case the vessels must have greatly lost their excitability to contraction, and the blood have lost its power of coagulating, being in the state which our forefathers called a dissolved crisis. Yet, from the ascertained possibility of a few apparently trivial scratches, even when no longer under the influence of the exhausted receiver, draining off such a quantity of blood in a few days, we may certainly learn the freedom, and the powerful concurrence of the whole circulation, with that which is, to appearance at least, simply external; and the disturbance which is likely to ensue in the whole from a check, or an undue excitement of the exterior subdivision of it; — facts which demand our most sedulous attention, and can admit of no approach to any consistent solution, without a due and patient reference

to the distinct powers and operations of the principle of life; while, at the same time, they present to us many circumstances, intelligible only from the ordinary laws of matter; warning off the truly philosophical investigator from any superstitious assumption; life being in all these cases the agent, matter the thing acted on, and the changes in matter the effects; which controul, but in no respect destroy, the inherent qualities of the substance itself.

We may confidently affirm of the vascular surface of the skin, that it would be entirely inadequate to its purposes, as a part of the common integument, were it not to bear such a part in the system of *sanguiferous transmission*, in addition to the uses it is to fulfil in the support, nourishment, and assistance of those other structures which are interwoven with it, and to its uses as a transpiratory organ, which are secured by the ultimate distribution of the vessels which depend upon this transmission, and on which I beg

leave now to suggest a few remarks and enquiries.

I must revert a little to the observations I have brought forward respecting both the exterior and interior epidermis; the latter following the former through its whole velaminated texture, and receiving underneath the sudatory vessels. What if I should consider this interior substance, so universally found under its more firm and incorruptible defender, as constituting one wide and diffused perspiratory gland, supplied by the vascular texture I have described, and being the medium of conveyance from it of that subtle fluid to the cuticle, which then exhales through its velamina, in every degree of gradation from the tranquil and invisible vapour of perfect health and ease, to the profuse and colliquative sweat of a languishing hectic, or the third stage of a fit of ague, or the clammy and panic-striking damp of the agonies of death? How else is it that our injections can penetrate no farther, when this incessant process never ends but with the end

of life itself? I waver, under the impression of my hardihood, in bringing before you a suspicion so novel, but which is more and more confirmed by every examination I have made into the subject.

That the perspiratory process is not merely a secretory, or separative one, but is also one attended with chemical changes, is demonstrated by many well-known facts, some of ordinary, and some only of occasional occurrence; such, for example, as the odour of the perspired matter, which from some persons is agreeable, in others sour and sickening; in others, as in the instances of Negroes and Mulattoes, generally offensive; and in almost every case is so from the feet; often also strong and discoloured from the arm-pits;—circumstances which seem explicable only from glandular, and therefore chemical, as well as separative changes in the material brought in its ordinary state to the surface of the cutis. The same remark will apply to various changes which are observable in diseases, especially in fevers, and other affec-

tions attended with febrile action, and generating morbific and infectious matter. These changes may, perhaps, begin in the capillary vessels, under the influence of the nerves connected with them, which we know, from analogy, determine, in a great measure, both the quantity and quality of the secretions or deposits separated from them. But it is probable that the nature of the parenchymatous substance of all glands has a share in determining the chemical characters of their respective products; and even that their excretory ducts themselves are not without some such contributory uses. In this view of the interior epidermis I am confirmed by a perfect certainty that the villi terminate in it. It sometimes happens, that from a sharp blow the cuticle and it are torn up from the cutis, perfectly colourless, but yet perfectly distinguishable; and I have watched them for a considerable time with a magnifying glass in this state, while the villi, of which the impressions were distinctly left on the soft surface which had quitted them, were bleeding below; and afterward derived a

most acceptable covering from its re-application, till the repair of the injury was accomplished. So that this seems the natural and appropriate recipient of the capillary arteries of the cutaneous secretion, which it imbibes under the protection of the cuticle, then transmits it through that exquisitely fine and delicate gauze, which may be called the safety-lamp of life and health. Indeed, the two Epidermides together form a double safety-lamp,—a protection of double amount, and of more than double value. I may here add, that on long maceration of cuticle, with which the substance in question remained attached, it falls into semigelatinous portions, and more resembles that into which macerated glands separate, than that into which cellular membrane, or muscle, or indeed any other structure that I have examined in the same manner, is reduced, appearing under the microscope in the form of irregularly granular particles. I do not lay much stress on *this* circumstance; but I cannot help thinking those I have enumerated carry much weight with them,

and derive some additional confirmation from it.

I am aware that a membranous appearance is found in skins affected by small-pox, and perhaps some other eruptive diseases, which has been called, from its discoverer, Baynham's membrane. But this is entirely a morbid appearance, produced by the eruptive inflammation occasioning an exudation of coagulable lymph, which glues together the capillary vessels, and renders them in that state separable, in a membrane-like form, from the subjacent corium; a circumstance of which I may have more to say hereafter. But it is not found in the perfectly healthy and natural skin; nor even in small-pox is it recognizable beyond the limits of the inflammatory influence of the diseased action.—But to proceed:—

In addition to the share which the vessels of the skin take in the circulation and the perspiratory secretion, they supply nourishment to other parts, either of its own fabric,

or so circumstanced as to be dependent upon them. Of these I must notice the nervous papillæ, the pores, the sebaceous glands, and the hairs; then the corium, and, finally, what has been called the cellular membrane, reticular membrane, or cellular texture; for the same trunks supply the vessels nourishing them all, and, indeed, make it difficult, in some points, to preserve an exact discrimination in speaking of these vessels, though I hope we are not in much danger of running into any injurious confusion.

The papillæ seem to have formerly attracted the greatest share of attention; for the more obvious papillæ of the tongue, which at its tip presents one of the most perfect organs of touch, so far, and perhaps so far only, as the delicateness of tact respecting surfaces is concerned, and the larger papillæ behind, led anatomists, naturally enough, to notice the resemblance of structure in those parts of the skin which present elongated villi after ordinary injection: but the assumption of their ge-

neral existence throughout the whole surface is amply supported, not only by sensations but by facts, which occasionally reveal them in a state of morbid growth, from the most minute which are observable, to what may be called, comparatively speaking, an enormous size. (See the plate.) Much that has been written and delineated, however, respecting them, is very confused, one might almost say imaginary, or perhaps has arisen from optical deception, in examinations with incorrect glasses. They appear to arise from filaments of the cutaneous nerves, which permeate the corium from within, in the same manner as the blood-vessels, and then form, most probably in close combination with them, an essential ingredient in the villous structure of the surface. Though so minute as to be only with difficulty distinguishable in a natural state, yet from their enlargement in disease, and from the analogy of their structure with that of larger animals, I believe they have generally, if not universally, a conical form; that each has an artery appropriated to its own nutrition,

which accompanies it to the termination of its point in the epidermis interior. This conical form being probably best adapted to the regular and imperturbed exercise of its sensitive purposes, keeping the finest tangible point in a state of support by a more compact basis, which serves as the peg which keeps the string of a musical instrument in its due accuracy of tension and fitness for vibration. Perhaps from its passage through the corium it derives a participation in the solidity of that part, the base of the papilla receiving from thence a delicate involucrum, which determines its form, and secures its competence to its uses, by the fixedness which sustains the exquisitely variable and correct mobility of its summit, in all natural conditions and gradations, without the risk either of laceration, or of inflammatory excitement. In the engravings published by Bidloo, and copied by Boerhaave and others, these truly nervous and sensible organs are confounded with the bulbs of the minute hairs, or pubescence, which have also a conical, but less erect and pyramidal form. The

observation of Haller is certainly well founded: — "*Non videtur pilus verus, papillæ hospes esse;*" —their structure, uses, mode of lodgment, and their whole arrangement, being entirely different, and their situation only contiguous, as we shall see more clearly by and by: yet so closely are they implicated, as to all functional properties, by this contiguity with the parts around them, and subtending them, as to be altered by every material derangement and alteration of structure which those parts undergo; becoming, under such circumstances, sometimes more painfully sensible, and at others more torpidly unfeeling than in a natural state; but in both cases conveying less perfect and intelligible impressions to the sensorium. The contact of other substances, which they are chiefly destined to give us notice of, if made under proper circumstances of temperature, force, and repetition, excites their sensibility to a more intense degree; which has been supposed to be attributable, and not without great appearance of reason, to their becoming at such times more erect,

as the nipple of the breast does on parallel occasions; while cold, exposure, fear, nausea, stupor, delirium, and palsy, diminish, suspend, or destroy their usefulness.

I must here, gentlemen, postpone awhile the farther consideration of this subject, as on next Tuesday, Professor Brodie's instructive Lectures on Comparative Anatomy will be resumed, and continued till he has completed that part of them which he has selected for the present season, after which it will be my duty again to address you.

In the lectures I have already delivered, I have had two objects in view; one to excite a further enquiry concerning an organ of great importance in the animal economy, with the structure and functions of which physiology, pathology, and therapeutics, must be closely and essentially connected. This, as it appears to me, has not of late years received a sufficient degree of atten-

tion; and its structure has, therefore, been but superficially examined. The other has been to excite, or I should rather say, to promote, the study of *minute anatomy;* for, without a knowledge of *minute anatomy*, we cannot sufficiently know anatomy for physiological or pathological uses. We may be good *mechanics*, but yet not equally good healers of those who require our *mechanical* aid. Moreover, minute anatomy opens to us a large field of interest and instruction. An eloquent French writer has justly observed, that man is placed between two infinites,—the infinitely great, and the infinitely small. Over his head revolve myriads of worlds, which surpass his utmost stretch of thought, by their multitude, their magnitude, their arrangements, and their movements; and which seem intended, among other magnificent purposes, to hold out to man a pledge of interminable sources of knowledge for his immortal mind: while in "*the gay motes that people the sun-beams*," and in the waters of the meanest swamp, float millions of living beings, and of the germs of living

beings, that the unassisted eye is unable to distinguish; and of which the eye that is best assisted cannot penetrate the organization. For myself, I must acknowledge, that neither having had opportunity nor leisure to enter far into the sublime science of astronomy, but feeling the sincerest respect and gratitude toward those who do, I have thought smaller objects more within my feeble competence: and here I descry the infinity that is beyond me; for even microscopes, which are calculated to magnify 8000 diameters, serve only to exhibit structures, the composition of which they cannot explain. So that it is most probable the formation of every created being, whether material or intellectual, will for ever remain a mystery, known only to Him, who has made all things according to the wise, but inscrutable counsels of His own will.

LECTURE VII.

May 6. 1823.

Gentlemen,

Professor Brodie having concluded his lectures for the present season, it becomes my duty to undertake the completion of this course; and, with the permission of the Board of Curators, I am going to deviate somewhat from the usual plan of that part on which it is now my duty to proceed. So that, instead of entering at once on subjects which are particularly considered as surgical, I may first conclude what I have to lay before you, on the anatomy and functions of the skin: for, indeed, without this, I could not completely fulfil my own wishes respecting the attempt, at

least, to explain those diseases to which our attention is generally directed, and the treatment appropriate to them. Inflammations, for example, existing in the various parts of the common integument, —whether phlegmonous or erysipelatous, whether ordinary and general, or specific, excrescences, leprous affections, many of the effects of scurvy, and an almost infinite number of constitutional disturbances,—require a knowledge of this complicated organ, for a satisfactory understanding of their manifestations. In all wounds it must be injured: many diseases commence in it, and extend their baneful influences from it to the most vital parts.

When I began to compose these lectures, and had fixed on this subject as the first to bring under your notice, I confess that I had no idea of the extent to which it would lead me. The farther I have gone, the more deficient I perceive the investigations of it to have been. I do not wish, by this remark, to convey the least censure upon others, or to arrogate the least credit to

myself. I wish to urge on enquiry, experiment, and a faithful comparison and adjustment of all the well-ascertained facts that can be collected; and the first, certainly, must be of those which are anatomical; as the basis on which all others must rest, or from which they must proceed; and then those which are physiological, pathological, curative, or alleviative;—an immense field of science, from which every other region in its vast extent, may contribute something to advance the fertilization; but which will require the aid of many industrious labourers to bring it even to that limited degree of fruitfulness and benefit, of which the circumscribed duration of human life, and its contingencies, can admit. However, we are all interested in it, both personally and professionally, that we may impart relief to others, and also receive it ourselves: for, you know, we have no exemption from the common lots of our nature; and the animating expression of Cicero, which has so often been quoted, may justly encourage our exertions:— " Nulla in re, homines propius

Diis accedunt, quam salutem hominibus dando."

Let us now examine the pores of the cutis,—those orifices which are so obvious on its surface, when the two Epidermides are taken off; which have usually been considered as fulfilling the perspiratory office; although it will follow, from what I have already laid before you, that they are differently destined, as to their *peculiar* duties; even if we may not doubt whether they have or have not any correlative allotment of function.

Of these pores there are millions, of various characters, on the surface of the body. But numerous, I should rather say, numberless, as they are, they would be far too few, too separated, and too large, to account for the ordinary and continual quantity, and process, of insensible perspiration; of which the most profuse sweat is only an excess; unless it be under violent, extraordinary, or rather morbid and disorganizing conditions. How far these pores may,

under such circumstances, contribute to the display of such morbid states and appearances, will perhaps be better understood, after we shall have more carefully attended to their respective distinctions and offices, their localities, and relative connections.

The orifices, called pores, are chiefly distinguishable in the corium, and are of three kinds. First, the residences of the bulbs of the hairs; secondly, those of the capilluli, or down, as it is commonly called; but which is, in reality, a congeries of very minute hairs, possessing similar, though not identical, characters and offices; and, lastly, those of the sebaceous glands. Here and there the places of transit of vessels and nerves make their appearance; but these, in number and amount, are very few compared to the rest, and are readily distinguished by the order, or, perhaps, I should rather say, by the uncertainty, of their arrangement.

The orifices indicative of the situations of the sebaceous glands are not always permanent in the corium when dried; neither are those certainly so of the minuter hairs, constituting the pubescence. Those of the larger hairs, like those of quadrupeds, remain, and are easily recognizable after the process of tanning. But should we look to any, or to all of these, for an account of the ordinary, or extraordinary perspiration, they could not explain it. This assertion appears to me so fully warranted by the facts I have already introduced, and supported by the preparations now exhibited*, that it hardly seems worth while to detain you longer upon it at present; but rather more imperative to examine those substances, by the attachment of which the appearance of pores, or perforations, to answer the purpose of exhalation, has been commonly, but too hastily impressed upon the notice of observers.

* A series of these preparations is deposited in the College Museum.

I shall first call your attention to the sebaceous glands; and this because they appear to be first, in order of function, in the growth and destination of the maturing fœtus; in which, toward the approach of the time of its expulsion from the womb of the mother, they are, comparatively at least, more numerous, more constant, and even more necessary, and more employed in the economy of the animal, than when it has emerged from its prison, and taken upon itself independence of life, and of activity. Incapable of respiration, the perspiratory office not being begun, neither urinary nor alvine excretions calling for discharge, consciousness not yet awake, the senses only in a state of preparation, and even the muscular energies only such as to give confirmation of its vitality, and of its being on the approach to fitness for its future condition; it chiefly requires a supply of nourishment and warmth, which it derives from its parent, to ensure its growth from within; and of a safe-guard exteriorly, to render all this compatible with the necessary conditions of its

temporary abode, and its approaching departure from it. Exteriorly, therefore, it is surrounded by the Liquor Amnii; which affords a gentle and equable support to the growing fabric, and protects it from many risks of injury from violence *ab extra*, during its early and pulpy state; and, at a more advanced period, seems destined at once to impede perspiration from the skin, and to prepare and keep fit that very skin for that very office, when it shall arrive into the more rare atmosphere in which it is to live. But in order to secure the cuticular covering of the skin from harm, by being so long macerated, as it were, in the fluid around it, these glands secrete a clammy, and somewhat unctuous substance, repulsive of water, which is entangled and rendered adherent to it by a soft and minute pubescence, composed of millions of capilluli, or little hairs, the roots of which rest upon or rather in the corium; they then pass obliquely through both the interior and exterior epidermis to the surface, to fulfil their offices. And the separation of these, leaves the appearance of pores.

Of the sebaceous glands, I have recently discovered there are two sets. One is well known, and is situated behind the second Epidermis, imbedded in the Corium. The other, I believe, has not before been detected. They are very minute, and lie between the second epidermis and the cuticle, to which they appear very firmly attached. I found these on examining the inner surface of some cuticle which had been macerated for more than six weeks, and from which the interior epidermis, having been broken down by putrefaction, was readily washed or rubbed off. These glands remained behind, and are clearly visible in the preparations I have made; entirely separate and distinct from the bulbs, or roots, of the capilluli. (See the plate.) In the lower figure, on the same plate, they are shown as seen through the exterior and semi-transparent surface of the cuticle; on which, in a good light, and by steady attention, the apertures of their sloping excretory ducts are also discernible, with the magnifying glass. They must, therefore, be

nourished by vessels of exquisite minuteness, which admit only pale fluids, and afford one, among many other illustrations, of the infinite and impenetrable wisdom, with which the most diminutive parts of our bodies are constructed and arranged. I once thought these might be glands appropriated to perspiration; but, on carefully tracing them through the whole surface, I perceived this could not be their office; for I was unable to find them in parts where perspiration goes on both evidently and copiously; but where the sebaceous or ceraceous secretion (for by this latter name I should prefer to distinguish it) is less called for. Moreover, in large cicatrices, where they are destroyed, although perspiration goes on, from the partially, or at least inferiorly, restored reticulated vessels, they are not reproduced with it; although the external cuticle, and also the internal, evidently are so.

That these glands have allotted to them a similar function to the deeper seated set, I am further convinced by a remarkable

case of a young lady, who consulted me some years ago, among other medical men in London, and in whom there were such countless numbers of them diseased about the left arm, breast, and back, as far to surpass any idea that could be justified by the knowledge we have of the sebaceous glands that are ordinarily seen, and which are situated *under* the interior epidermis. They, however, were constantly turgid with the sebaceous secretion, and produced continual irritation underneath. I could not conceive where such numbers of glands could be lodged; but I have now no doubt of their being in the situation I have at length detected. *

The *deeper seated* set, as I have observed, reside behind the inner Epidermis, cherished, supplied, and influenced by the reticular and villous texture of the blood-vessels and nerves, and attached to the coriaceous part of the integument under-

* My son has counted 140 of these in a quarter of a square inch, which will make them amount to nearly 120 millions on the whole surface of the body.

neath them. They have sometimes been called miliary glands; their minuteness and rotundity giving them, as was thought, a resemblance to grains of millet-seed. It is better to denominate them from their office in the animal economy, and to preserve the term sebaceous, or, as I have called them, ceraceous, as more indicative of the nature of their secretion. Not, however, that it is either suetty, or readily inflammable; for the matter they supply is of their own distinct production and character; but in several of its uses and properties it bears an analogy to those, which we frequently derive from fatty, or waxy matter, in the ordinary businesses of life. It repels aqueous fluids, so as to call for the employment of saponaceous substances, which incorporate with both, readily to cleanse the surface which it overspreads. To a certain degree it prevents the dangers of friction, without diminishing sensibility. It is curious to observe how the tip of the nose of the sucking infant, its lips, both within and without, and the contiguous parts of the chin and

cheek, are studded with these glands, to enable it to nestle, as it were, with impunity, on its mother's breast; where it is first to feed, and smile, and play, in all the simplicity and dependence of unprotected infancy; angry to be refused, eager and happy to obtain, and fully contented to enjoy, the earliest repast of nature's luxury; and then, and there, unconsciously, to sink into innocent and happy repose: while a correspondent arrangement around the fountain of its protectress, enables her to afford the fostering supply, with gratification to herself; and to look down on the feeble and tender object of her care, with all the delights, and wishes, and anticipations, of maternal fondness and solicitude.

In after-life, the smoothness, and softness, and polish of the skin, and its adaptedness for exposure to a great variety of external changes, depend greatly on these glands, and on the health, regularity, and uniformity of their secretion; showing the wisdom of that secretion not having been committed to large, or distant, and pro-

miscuously scattered organs; but being entrusted to myriads, in regular and appropriate distribution; furnishing every portion with a kind of never-waking Argus, with its hundred eyes, to watch over its own district, and to keep up a regular correspondence with the whole.

Exposed to many dangers, they are subject to many diseases, and I may hereafter have occasion to call your attention to several of them. In the mean time, let us glance at their neighbours, the capilli, and capilluli; and that substantial residence, support, and security which they derive from the coriaceous texture over which the whole complicated organ we have been describing is spread out. Portions of the animal fabric, which, perhaps, of all the obvious and uneludable parts of the body, have been most of all neglected in man; while in quadrupeds they have engrossed, and justly occupied in all ages, almost the whole concern of a large proportion of traffickers and manufacturers, in every part of the world.

Both the longer hairs, and the pubescence, which consists of an infinite number of minute hairs, have this in common, that they grow from small bulbs, imbedded in the surface of the Corium, where they are supplied by vessels from the reticulated plexuses, appropriated for their nourishment. From hence they pass through the interior and exterior Epidermis, at very acute angles, closely embraced by both, especially by the latter, which sheaths their protrusion so firmly, as not to allow them easily to be detached, even after a length of maceration and putrefaction, which has been sufficient to destroy the interior Epidermis, or, as it has been called, the Rete Mucosum; so that, in this respect, they resemble the nails. It is evident, from this arrangement, that the capillary perforations cannot be perspiratory; for the obliquity of their course, and their firm adhesions, would oppose a serious, if not an insurmountable obstacle, to the transmission of any thing through them, while they are in a natural state. It must constitute a perfectly valvular obstruction.

The hairs are inserted, or perhaps I should rather say rooted, on the exterior part of the Corium, in such a manner as, together with this obliquity of their direction, to make them astonishingly secure in their allotted situations. In a great number of animals, they appear to be like slender horns, conical in their form; and, as it were, hermetically closed at the point, and are periodically shed off. In the sheep they continue to grow, that they may be sheared for the benefit of their purveyors and protectors. For wool is hair, adapted to particular circumstances; and we know that change of climate will, in some instances, cause a change from the one form of growth to the other, so as to fit the animal for its new residence. In man they are tubular; and the tubes are intersected by partitions, resembling, in some degree, the sap-vessels of plants; such, for instance, as are beautifully seen in slitting up the leaves and stalks of the Sparganium ramosum, and other aquatic plants, which are now beginning to shoot up their beautiful, but obtrusive and deceitful verdure,

at the muddy sides of our ponds and shallow streams. Being intended for protection from violence, as well as for covering, they are thus formed on the same principle as the bones themselves; their hollowness preventing incumbrance from weight, with rather an increase than a diminution of their powers of resistance, on account of the rounded form of their transverse sections,

Whether the hairs transmit any secretion, may be worth enquiry. That those of the head have a peculiar odour, which is often retained for many years after their separation from it, is well known; and we have cases on record in which the removal of them from the head, at an early period after acute diseases, has been followed by alarming symptoms, scarcely to be accounted for by the mere additional exposure to cold. But, at all events, when the extent of the whole capillary system is considered, (for to an attentive observer it will soon appear that Haller is right in asserting, " *Homo ex sua natura hirsutum est animal; et formosissima femina faciem*

totam hirsutam habet,") it will be found to bear no inconsiderable or unimportant proportion in the animal economy; and it will necessarily follow that those diseases of the skin, which extend deep enough to destroy their originations, must, on this very account, even were that all, expose the whole frame to some serious derangements. If the morbid state of one gland, as that of the breast, or an absorbent gland, shall affect the whole constitution with disease, these parts, so countless in number, and essential in function, may be naturally expected to have an influence of large, though perhaps not so immediately perceptible amount, on the general health of the body; making up by their numbers for the smallness of their size, in the share they, and the pores into which they are inserted, take in the balance of the constitutional actions.

It must further be observed respecting the Capilluli, that they pass from the Corium to the surface of the body, in pairs, or triplets, perforating the reticular vessels,

and both the Epidermides, at very acute angles; so that by the form of their bulbous insertions, and the direction in which they proceed outward, they serve to connect together all the parts of the integument, like so many fine pins, or fastenings, adding to the integrity and security of the whole compages. (See the Plate.)

The structure of the bulbs or roots of the hairs, as developed in my son's drawing, (see the Plate,) seems to throw considerable light on the pathology, and something perhaps on the influence of the remedies, for Plica polonica; — a disease which, from what I have learned of it, especially from Professor Herberski, of Wilna, and Professor Wagner, of Berlin, seems, both in its progress and its cure, to confirm the idea I have suggested, of the capillary system bearing a material proportion in the cutaneous functions.

I must not leave this part of the subject, without adverting to the part which the skin, in all probability, takes, in that duty

which is principally fulfilled by the lungs. It was by the communication of oxygen to blood through the coats of a bladder, that Dr. Priestley first opened to us the light which has since been thrown on the efficiency of respiration. That change is frequently produced in the stagnant blood in the vessels of the cheeks of many persons after death, especially of those whose complexions have been florid, and more particularly of females. This alteration has so much, in some instances, renewed the appearance of life, that I have been several times called upon by the tender anxiety of affectionate relatives, to say whether the party were dead or not, before the funeral ceremonies were proceeded with. But the flaccidity of the cornea, which almost instantly follows dissolution, and the transudation of the fluids to parts laid in a depending situation, which speedily ensues, will always suffice to settle this question. The doubt could only have been raised by the fact of the oxygen of the atmosphere combining with the dead blood, so as to produce an approach to the ap-

pearance of life, and goes in verification of the mode of transmission through the cuticle, both from without and from within, which I have before noticed ; for the blood, though thus oxygenated, does not exude. May not this circumstance, however, throw some light, a melancholy, and perhaps an useless light, I will confess, on the heat and flush of hectic fever? When parts destined to a particular function become incapacitated to fulfil it, all others that are capable of contributing to it, seem, as it were, to be instinctively pressed into their service. When the ordinary muscles of respiration, — the diaphragm and the intercostals, and so on, — fail in their powers, see how the sterno-mastoidei, and all that can assist in dilating the thorax, take on an unnatural action, to share in the struggle! So when the lungs become tuberculated, inflamed, and ulcerated, the vessels of the skin are violently compelled to hurry on their action, to force on the oxygenated blood before its ordinary change there can take place ; and to catch the smallest breath they can imbibe, to cherish the lamp of life,

till the feeble and flickering flame is at last obliged to forsake the material which supported it.

My late friend, Dr. S. H. Jackson, many years ago had made some ingenious conjectures on this subject; but he had not been habituated to philosophical and experimental investigation; and therefore he did not make out any facts with adequate distinctness; but it has often astonished me that the observations and experiments relating to it, which were published by Mr. Abernethy so long since as the year 1793, should not have attracted a greater share of attention, and have led to a farther prosecution of the enquiry which he instituted into the functions of the skin, with his accustomed zeal and discernment. He ascertained, among several facts of considerable interest and curiosity, that the perspired matter differs in quality as well as in quantity; that both carbonic and nitrogenous gases are perspired, and also imbibed, through the skin of the living body; that oxygen is also abstracted from

common air, and absorbed, and this with great readiness; so that in eight hours eight ounces of oxygenous gas was imbibed by the hand and wrist; though, in a similar exposure to nitrogenous gas, only one ounce of the latter was absorbed. The account he has given of the proportions of the absorption of different airs, shows how complex must be the functions of the organ we have been contemplating, and how very much we still remain in the dark concerning them; especially when we add to all those facts, the prodigious absorption of aqueous fluid from the atmosphere, which is remarkably demonstrated by many cases of dropsy and of diabetes.

Mr. Abernethy found also, that, besides matter purely gaseous, on an average, about two pounds and a half of aqueous fluid were perspired daily, from a person five feet six inches high, and of proportional bulk; and he takes occasion, from the whole of his observations, to make some highly interesting remarks on the reciprocal influences of the cutaneous and *pulmonary*

functions; and especially on the effects of impediments and checks to the fulfilment of the former, in producing diseases of the lungs. A fact well known for a long time; but not before placed in so correct and scientific a point of view; or in one so indicative of the necessity of farther investigation on this very account, as well as for the sake of demonstration of the source of glandular disease, from the suppression of perspiration; or, as I might more correctly express myself, the suppression of the actions of the *Organ of perspiration.*

A subject equally deserving of notice is the relative connection, sympathy, and dependences of this organ, with regard to the intestinal surface, and the contents and secretions which may be lodged or produced there. For, from the commencement of this tract of bowel in the pharynx, to its termination at the extremity of the rectum, an indissoluble connection of function with the skin is discernible. A disturbance in the earliest part of the canal often

throws the fine branches, and anastomosing connections of the recurrent nerves into disorder; convulses the stomach, and sets the secretory vessels of the skin in extraordinary action. No sooner are some substances received into the stomach, than the skin begins to show its displeasure, and imperatively to require the relief of its associate from the unwelcome intruder. Erysipelas, Urticaria, and very frequently minor annoyances, give ostensible notices of the enemy within; hold out the signals of distress, and sometimes of danger; call aloud for prompt assistance, and if it be unattainable, lead on to serious, to long, and, in some instances, to fatal disease.—Facts which show the vast importance of a due study of the nature, offices, and derangements of the several digestive organs, their separate and combined uses, and the influences of remedies upon each. And here I look much to the stomach itself. Its actions and secretions are still mysterious. We know not why the gastric juice dissolves all sorts of food during life, and dissolves the texture of the stomach itself

after death. We cannot always tell why one thing shall in some cases offend, and in others please, this tyrant of the body. But it must not be an unconsidered object of our attention, either in diet or medicine; nor, which is more to my present purpose, in the covering, the ablution, and the remedies of the cutaneous organ. — I perhaps ought to apologize for the frequent repetition of this epithet; but I know not how to avoid it; for the more I consider the subject, the more I see of its importance generally, and of the separate importance of its several parts; of our, or I should rather say, of my own imperfect acquaintance with them; and the propriety of inviting the attention of others, to a more full and experimental enquiry into them.

From sudden, or from continued exposure to cold, hot, impure, foggy, and loaded atmospheres, how many changes arrive! Not only are the eyes, the nose, the ears, the palate, the throat, almost immediately, and often violently disordered; but parts not in contact with them, in con-

sequence of their relation to the skin, and the impossibility of carrying on their functions without it also is healthful, become, as it were, enraged. Vomiting, inappetence, indigestion, costiveness, or diarrhœa, are produced. The actions of the liver, and its dependent and assisting viscera, are disturbed; every thing goes wrong; and unless the cause be removed, the effects are not very likely soon to cease. So also, on the other hand, should the viscera of reception, digestion, absorption, fæcification, or evacuation, be deranged, either from substances taken from without, or generated within, I have already hinted how Erysipelas, Urticaria, miliary eruptions, and febrile heat, may arise, with great suddenness and violence, so as to force the skin imperiously to demand the prompt expulsion of the unwelcome intruder upon the peace of its friend. Instances like this are often seen after eating muscles, lobsters, pickled salmon, &c.; and excess in any thing may occasion them. I have known them brought on by eating an apple hastily, when the patient was rendered heated and

thirsty by riding. And there are peculiar substances, that very generally agree with persons in general, which nevertheless produce these effects on particular individuals. I once knew a lady who could not take *powdered Rhubarb* without an erysipelatous efflorescence almost immediately showing itself on the skin; and yet she could take the *infusion of Rhubarb* with perfect impunity; perhaps because the woody particles of the powder adhered to, and irritated the mucous membrane. In some instances the evil is, in general, very transient, and easily removable; but in others it is more permanent, and difficult of cure. And in cases less strongly marked, other outward and visible signs may nevertheless be often readily discovered by an accustomed and observant eye, in the hue and general appearance of the integument. But whether they be readily observed or not, their effects are real, and often important;—circumstances of great consequence in the Practice of Surgery, as well as of Medicine; for if we do not keep an eye upon them, so as to direct the clothing of our patients,

the ventilation and temperature of their chambers, and the due cleanliness of their persons, and also that of their attendants, evils may be communicated, or originated, from the skin, which shall frustrate our best endeavours, by throwing the viscera into a state of disorder, or keeping them so; and thus tending to suspend, or destroy, the digestive, the nutritive, and, of course, the restorative processes of nature; and therefore to diminish the general strength, to weaken the nervous energies, without which no repair can go on; and to lead to those excesses or deficiencies of the ordinary excretions, which so often interrupt and defeat the exertions of the constitution, and the sanguine hopes and expectations of the Surgeon.

Nor may we safely overlook the connection between the *renal* and *sudatory* systems; the secretions of which have been thought, and not without the appearance of reason, to be in many respects similar to each other. At all events, we know that copious perspiration diminishes the quantity

of urine, and renders the quantity of salts and of lithic acid more abundant in their proportions. And through the skin there must, in many cases, as of diabetes, be a great quantity of aqueous matter absorbed from the atmosphere. We know also, from the histories of some shipwrecked persons, that even under a state of constitutional health, a degree of sustenance appears to have been afforded for a time by their dipping their clothes in the sea, and wearing them wet. The effect of these circumstances on the quantity and quality of the insensible perspiration, I believe, has not yet been experimentally ascertained; but it may be worth bearing in mind by those, whose professional destinations may call them to appointments, where such enquiries might be instituted with sufficient delicacy and prudence.

Moreover, we must bear in mind other sympathies, established by the close interweaving of the nerves and vessels in the skin, and often reaching to distant parts; manifested in the relief of affections of the in-

ternal organs, as the liver, the lungs, &c., both by stimulating and soothing applications, applied externally; sometimes where no direct connection appears to exist, but which are strongly illustrative of the able remarks on this subject recently made here by Mr. Brodie; and of the doctrine of remote, as well as that of continuous sympathy, taught by Mr. Hunter, and very imperfectly understood before his time, although sufficiently known to be in a good degree acted upon. All tending to show, that the nervous system is to be considered as one great whole, of which, indeed, each part has its distinct allotment, but can never, in a natural state, nor in morbid conditions, in general, be absolutely independent of, or disconnected from, the other parts of that mysterious portion of the animal fabric.—A subject highly deserving of serious, and accurate, and scientific examination and reflection, both in pathology and in practice.

LECTURE VIII.

May 8.

We come now to consider the Corium,—that firm stratum of the skin which forms the basis, on which the parts we have already noticed are spread out and supported; underneath which, and protected by it, the bones, and joints, and muscles, fulfil their allotted range; and sustain, undisturbed by injury or decomposition, their respective offices, in the ordinary and healthful occupations of the body. Its structure, as you know, appears chiefly made up of a fibrous substance, the threads of which are interwoven with each other in various directions, so as to give a compactness which remains long after death. And when it has been subjected to the process of tanning, and the gelatine is united to and coagulated

by the principle communicated by that process, the skins of many animals form that useful and almost indispensable article in commerce and clothing which is called Leather. Sir A. Carlisle informs me he has been told by several of their Chiefs, that a somewhat similar change is wrought in it by the North American Indians in another manner. It appears they make a kind of lather with the brains of the wild deer they kill. In this their women knead the hides for several hours; they are then hung up to dry, and, after remaining for a certain time, become unputrescible, and resisting water, so as to be fit for gaiters, or *leggings*, as they are called. Of this process I had intended to make some experiments myself, but my long and severe indisposition has interrupted me. The subject, however, is curious, and may be worth the notice of some gentlemen who have more leisure to pursue it.

In man, this substance is usually thin, when compared to the bulk and extent of his whole body; but a preparation on the

table will show you a state of disease, in which it has become inordinately thick; and this without any other change in its structure; almost the whole disease in this case, appearing to have consisted in an enormous overgrowth of every part of the integument of the right lower extremity. (See the plate.) In many animals its thickness is so great as to form a perfect coat of armour for them. This is particularly the case in the African Elephant. In man it is found rather closely applied to the subjacent parts, and its connection to them by cellular membrane, only loose enough to allow of the ordinary movements of those parts. But Mr. Haslam, in his interesting observations on madness, remarks that he has frequently noticed in persons who have suffered a long and violent paroxysm of that disease, that the scalp, particularly at the posterior part of the head, has become so loose, that a considerable quantity of it could be gathered up by the hand. Many years ago, there was a female gipsy, who used to show her-

self at the anatomical schools in London, who had a large portion of loose skin on the left breast and side, which she could wrap over her body, to a considerable extent. In many women who have been repeatedly pregnant, and in persons who have recovered from ascites, the skin of the abdomen becomes lax, in a somewhat similar way. But this is not uniformly the case; so that the varieties in this respect afford a proof of the influence of the principle of life on this substance. Yet there are other properties, which it seems even during life to possess, as well as after death; particularly in that of receiving impregnations, both from vitiated secretions, and by substances introduced under the cuticle. The marks made by soldiers and sailors on their arms are in proof of the latter, and freckles of the former; these being not, as has been supposed, affections of the interior Epidermis, but of the Corium itself; the living qualities and adaptations of which more concern us on this occasion.

In this view, it appears less mutable, and less easily regenerable, than the rest of the integument; and although we see it is renewed in the cicatrices of wounds and ulcers, yet the renewed part is less perfect, less tenacious of life, less capable of giving its support to the newly formed, and then supplementary reticular texture of vessels, and to the interior and exterior epidermis, which are superinduced over it. When it is regenerated after entire destruction, it contains neither capillary nor sebaceous pores,—circumstances which strongly mark the necessity and value of saving the skin, that great improvement in modern Surgery, when its soundness will permit, in extirpatory operations; and point out a great source of the evils which are found to follow severe cases of small-pox, in which this part becoming impaired by the deep ulceration, or destroyed by the sloughing, which so often take place during the secondary fever, throw the whole cutaneous circulation, and the offices of millions of little glands, into a state of derangement. This will take place, however, according to the depth of the ul-

ceration, or slough; and, though the balance of these things may in time be restored, as we find to be the case with the circulation of the blood, where the principal vessels have been tied or obliterated, yet the alteration must for a time be followed by irregular and unnatural determinations to other parts; and often bring on, as we see, glandular diseases, diseases of the joints, and bones, and eyes, and of the rest of the skin: and this especially in large towns, and in close and unhealthy situations, which are unfavourable, under the best of circumstances, for the perfect fulfilment of the transpiratory and other cutaneous functions, as well as for that of the lungs. If, therefore, the discovery of the power of Vaccination had no other merit than that which it unquestionably has, in cases where it does not fully prevent the reception of variolous infection, of cutting off from the disease the fatal stage, in which these terrible ravages are principally made, it would be a remedy beyond all price, worthy of universal adoption, and even of general enforcement by legal provision.

Perhaps one reason of the little mutability of the Corium is, that it consists chiefly of very strong fibres, and a parenchymatous substance, which, although living, have but few vessels allotted to their own uses, and need but few. It is chiefly, in respect to vascularity, more a transmitter than an employer; and a noble and well adapted structure it is to sustain this duty, with little interruption in the exercise of it, on account of the combination of firmness and softness in its contexture. It is also elastic, and conforms itself to all natural states of the perspiratory organ which it subserves; shrinking when its vessels are incompletely filled, and drawing along with it, in its contraction, both the Epidermides, to which it is so nicely attached, by the innumerable ligamentous junctions I have before pointed out. Thus, by the gentlest compression, it withholds for a time from the glandular apparatus, a supply, of which they cannot in such moments dispose; while again it readily yields to the natural return of the blood, through its former transit, and becomes accommodated even

to many excesses of fulness, strength, and rapidity. Were *it* equally irritable with all these parts, it would be unfit to preserve *them* in a steady and consistent state, during so many variations; but its vitality keeps it in complete harmony with them under all, with as little as possible participation in their disturbances. Hence it is also adapted to all periods, and all natural states of life, and to the many alterations in the bulk of the body, from infancy and maturity to extreme old age. The muscles grow from use, and diminish from inaction; fat is deposited in small or in larger quantities, and is re-absorbed in fever, or from declining health; but each of these changes takes place under the protection of the same permanent and unaltered tunic.

Immediately underneath it, the cutaneous arteries are distributed in an arborescent, or ramified form, anastomosing freely, so as to secure the regular supply of the reticular and villous texture, which is their ultimate destination; and which they feed

with the pabulum for their constant secretion. Here they are retained by the cellular membrane, into which the structure of the Corium itself seems gradually to subside; so that it is sometimes a nice point to distinguish where one absolutely ends, and the other begins. By this arrangement the vessels are kept at once fixed and moveable; fixed with regard to the definite and allotted position and purpose of each; and moveable, as a connected tissue, attached to moveable parts. Indeed, to parts not only moveable, but perpetually varying, in the minuter conformations of their respective surfaces, to an infinite variety of transitory circumstances. Who can behold the human face for any length of time, with a contemplative eye, and witness its alterations in complexion, in feature, in all the expressions of passion and emotion, and not admire, if his attention be directed to this object, the transcendent wisdom, with which the integument is thus adapted to the numberless, the distinct, and yet consentaneous mobilities of its smallest subdivisions; conveying the unerring signs

of hatred and love; of disgust and of delight; of doubt, of distrust, of grief, of malice, and of contempt; of veneration, of pity, and of revenge; of pride and of humility; of envy and of benevolence; in all their gradations and conflicts, in a silent language, intelligible not only to all mankind, but even, in many instances, to the very beasts that obey us?—A buck that was fixed on to be shot, and had never feared his keeper till that purpose was formed, but had mingled heedlessly with the rest of the herd, no sooner saw him enter the park with an intention to shoot *him*, instead of another, than he instantly took to flight, and, in a violent effort to leap over a high wall, bruised one of his haunches, and fell down a prey to the danger he was endeavouring to avoid. In dogs we often observe a prompt obedience to the will of their masters, when that will is expressed only by looks, or gentle motions.

Now on what does all this depend? not merely on the muscles which act upon

the integument, but on the fine adaptations of the surface which is acted upon, to obey the minutest mandate of these its masters, and to concur also, by marks and characters of its own, in the intentions of the superintending mind. But for purposes less obviously cognizable, though not less real, every individual portion of the integument is equally adapted to the numberless variations of movement which belong to the parts it invests; so as to be alike accommodated to the most athletic exertions of Herculean force; to the nicest touches of caution and examination, and to the feeblest quiverings of languor or timidity. And all this in complete consistency with the regular fulfilment of the cutaneous functions, which go on, unconsciously and uninterruptedly, however they may vary in degree, between the cuticle without and the Corium underneath.

To the maintenance of this balance, and this unconfused appropriation of uses, the structure of the Corium must essentially contribute; for it is not composed of fibres

arranged like those of muscle, having one determinate course; or in an angular arrangement, so as to act in diagonal lines; but of a web-work of fibres, interwoven in every conceivable line, supported by the gelatine of its parenchymatous substance; so as to combine firmness, flexibility, and competent elasticity, in every possible direction, and combination of directions. I do not know that I am at present authorized to ascribe muscularity to it; perhaps it approaches more to the nature of elastic ligament, and is antagonized by the muscular actions in the vessels subtending it, and subtended by it. Such at least is its texture in the human body, which we have now chiefly to consider. But the part itself is common to all animals, unless we except some insects; and its conformation in each is adapted to the habits and conditions of each kind respectively, in all its properties. In the African elephant it is so thick and so fluted as to appear capable of repelling the force of extreme violence. In the rhinoceros, though less thick, it is also, as it were, fluted in crossing lines. How

soft, and yielding, and silky is it in the infant and the human female! How impenetrable in the Cuculus indicator, or honey guide, in Africa; so as to resist the stings of the wild bees, on whose honey it feeds, and to whose hives, by its noise in the trees and other hiding-places, it directs the hungry and fainting traveller through the woods, for refreshment and supply! Nor, without the peculiar resisting properties of this substance, would Vulcan himself have been able to make the seven-fold shield of Æneas, at once wieldy and impenetrable.

Its firmness is secured by its fibrous part, and its flexibility by a more soft and soluble gelatinous substance, that is interposed between the threads; and its elasticity by the union of both. A part of the latter, the softer material, is always, and sometimes the whole, extracted in the macerating pits of the tanner, before it is subjected to the full influence of the tannin. When any remains, it also is combined with the tannin, and remains interposed between

the fibres. My own examinations, so far as they have gone, lead me to believe, that the various degrees of hardness and flexibility in leather, much depend, *cæteris paribus*, on the proportions in which this disunion of the more soluble part from the thready is allowed to take place, before the finishing process; though undoubtedly much must follow from the ingredients employed, and the length and circumstances of exposure to their influence.

On looking at a thin slice of the injected human Corium from the wrist of a man, after the superjacent parts had been removed, it appeared to consist of a close and little varied texture. I allowed the portion to dry on the glass, and then re-examined it. The principal vessels were passing through it at very acute angles, on their way to the reticular intertexture, where their final functions are performed. On macerating another portion for several months, the Corium separated into the two distinct substances already mentioned, — the fibrous and the pulpy. The former is the

more ostensible matter of the compound, which serves for the nidus, or resting-place, of those parts of the cutaneous organ, which fulfil the most obvious uses for which it is constructed. But the granular portion, perhaps, may answer some other end than that of giving at once flexibility and compactness to the Corium. I have lately been much inclined to think it possesses some muscular power, analogous to that in the pallium of the molluscæ, or the chrystalline lens; but I do not assert that it has. I only throw out the idea, which I am more readily disposed to indulge, because I have found that, like muscle, after maceration, it becomes sooner changed into that spermaceti-like substance called adipocere, than many other parts in the frame; though most, if not all of them, except the bones, the Epidermides, and the humours of the eye, are liable to this mutation.

It must moreover be observed, that the coriaceous texture is a bad conductor of heat; and thus serves much to preserve and equalize the temperature of the parts which

it covers, and protects from sudden and violent changes, under the variations of the surrounding atmosphere, in so many different climates as man is destined to inhabit. And it is interesting to remark, what I have indeed before alluded to, that the vascular texture of the integument, which is itself a good conductor, is so guarded by a bad one underneath it, and two bad ones over it, as to possess a lodgment, in this respect, of triple security to the perfection of its own functions; which so much depend on a moderated uniformity and constancy of its own temperature, while such a copious and subtle evaporation is continually going on. And how wonderfully, in various tribes of animals, have hairs, and wool, and feathers, and scales, their distinct and perfect articulations, to adapt them to their several abodes, and diversified habits of action! Neither could the lark nor the eagle soar, nor the vulture descend, to riot on the liver of its prey, nor the fish cleave its wavy abode, nor the lion shake his majestic mane, and overawe the strongest beasts of the field, without the due arrangement of those

millions of joints which their formation displays, between all those distinguishable and separate organs of movement and of endurance, which are formed between the Corium and each of them individually. The violation of either of these constitutes a sensible injury; sometimes, indeed, transient, and speedily forgotten; but in other instances, especially where the frame is præternaturally irritable, capable of exciting considerable disturbance. Nor without this harmony of united, and yet moveable parts, could the Turkey amuse us with his ridiculous strut, or the Peacock and the Argus with the gaudy display of their plumes. By its secure arrangement the Seal, the Walrus, and the Bear, riot with impunity in the frozen regions of the north; and the Camel and the Dromedary fearlessly traverse the burning sands of Africa and the East. While, without any such provision as plumage or hair, and by the protecting nature alone of the Corium itself, the stupid Rhinoceros, and the sagacious Elephant, defy the power

of a tropical sun; and the sturdy tribes of cetaceous fish, play almost fearless and uncontrouled, in the boisterous waters of the mighty deep.

LECTURE IX.

MAY 10.

WHEN we have divided the protecting investiture of the body, to which our attention has been hitherto chiefly directed, and before we arrive at the dissection of the more compact and solid parts, we come in contact with the Tela Cellulosa, or, as it is commonly called, the Cellular membrane; by which most of the various textures are held fast in their respective relations, and boundaries of duty. A substance this, which appears to be the most simple in composition, and probably on that account, in part at least, the most readily disordered, and the most easily regenerated, of any structure in the animal fabric. And, indeed, is not only the most easily regenerated, but the most easily pro-

duced, in the remedial processes which occasionally take place, and without which the effects of diseases now capable of cure, would, in many instances, become hopeless. It is chiefly, however, by tracing its formation and changes, under and after disease, that we gain a tolerable idea of its *real* nature, and are enabled to understand the extent of its important uses. From hence we find it to be originated from the coagulable lymph, or fibrine, of the blood, in its most simple and ordinary state of effusion, when entered, as it speedily is, by germinating vessels; and we have, in all our Museums, preparations, demonstrative of the various stages of the conversion of this substance into all the various appearances and uses that it assumes. When we come hereafter to follow onward the effects of inflammation, we shall see this amply demonstrated. At present, we must attend more to its natural and undisturbed state, or rather states, for they are many, suited to many purposes, by appropriate diversifications of texture and arrangement; from the most yielding, to the

most compact and inviolable. The view which Haller has taken of it can hardly be surpassed: he has justly observed, that this same substance exists from the minutest fibril, to the most compact *thecæ*, by which the trunks of arteries and veins are kept safe in their appointed courses.—So numerous, and so well suited is it to all the parts it at once connects, and leaves in the exercise of all allowable liberty, as to render it a long and somewhat perplexing task, for an accurate, or at least a minute anatomist, to investigate, to ascertain, and to discriminate its appearances and connections; sometimes being so tender and feeble as to break under the slightest unnatural violence; and elsewhere so firm and close, as to require the most cautious eye, and the most skilful hand, to separate and disentangle the parts of which it is the safeguard.

It behoves us much to notice all these facts with care; and the peculiar circumstances and relative connections in which they severally occur, and to mark the changes by

which they are occasionally modified. For, although in some of the greater operations we can treat the cellular texture without much ceremony, as a thing of only secondary importance; still, in those which are more delicate, where the parts requiring them are more minute and complicated, and where the variation of a mere touch may be of importance, it is requisite we should not only know the general and obvious path, but every step also of the way we are to take.

As a part of the integument, however, to which point of view I am now chiefly to confine myself, the cellular texture is to be considered as distinguishable into two parts, if indeed they be not two states of the same substance; and not two different substances, destined to separate uses. At all events, the appearances they exhibit both agree and differ; the agreement and the difference being not vague and casual, in the original conformation of the body, but confined to certain situations, and evidently designed for differing purposes. But thus far

they are alike,—that the portions destined for the residence of animal oil are often, as in some cases of dropsy, destitute of it, and are left so empty of their ordinary contents, as to become no richer than their neighbours, and to sustain very much the same obvious characters. But there are other portions, into which fat is never deposited, and where it would amount to a total defect of all the uses of the organ in which it exists. So strict and inviolable is this appointment, that the cellular and adipose membranes have been considered by some physiologists as two distinct substances. At least, they have distinct, though, in some instances, consentaneous and conjoined allotments. This, however, is not less curious than the instances of other contiguous secretions, that from adjoining and connected arteries, ramifying through a material so similar, if it be not identical, fat should be furnished in one spot, and never enter into another, which borders close upon it, and does not appear to be separated by any definite capsule. I confess I am inclined to believe that every cell containing adeps should

be considered as a separate and appropriated gland. In the medullary fat of the bones, its globular or granulated appearance has long been known to give countenance to such an idea; but it did not appear to be borne out with relation to the fat in other parts. In a preparation, however, of the integument over the eye-brow of a fœtus, which I put up more than twenty years ago, I found, when examining it a few days since, that the gradual corrugating influence of the spirit of wine had gently forced it from its cells in a solid form, having the form of separate globules, like the marrow; and, as I think, authorising the opinion that they are both produced in like manner, in the parts where they are respectively found. Yet in after life, when the integument is more exposed to external pressure and violence, it may be less definitely confined to its original cells, and therefore its original mode of deposition less readily cognizable. It then more effectually sustains the elasticity of the skin, and is an important medium of resistance and defence.

But I perceive I am in danger of wandering into a too divided and intricate discussion of a subject, which would be more easily understood by careful distribution, than by the hasty and cursory combination of its parts. My apology must be, that I know so little about it, and that I am sincerely endeavouring to excite others to acquire more perfect information.

Nevertheless, the facts of which we are in possession, show us that this fine and beautiful web is so constituted as to admit of the readiest transit of various fluids from place to place, without serious interruption, under some circumstances; and perhaps in all the instances of natural function and secretion; while, in many diseases, it is so closed up and circumscribed, as completely to shut out the causes of disorganization from the most contiguous vicinities.

We therefore find it sometimes fibrous, or thready; at others, laminated and more membranous; at others, again, intermediate and somewhat dubious, or unde-

finable, as to its exact form of arrangement; but always in that which is most fit, and relative to its purposes, in every part; whether it be employed for connection, for retention, for motion, or for support, in any and every degree of appropriation. And when we survey this, in connection with the varied and peculiar degrees of vascularity and sensibility in the parts, especially the more minute ones, betwixt which it is interposed, as their mutual bond of union, we may more readily understand the results of those morbid conditions into which it is so often brought; and that in many instances determines the difference between hearing and deafness; between blindness and sight; between numbness and agony; and even between life and death. For it must be well known to every Surgeon, who has had large opportunities of observation, that cases occur of superficial inflammation, as far as external appearances go, and where no vital organ appears to be distinctly or directly impeded in its duties, but in which the cellular texture becomes a quagmire of mortified

substance, and sets before the constitution an indispensable task, to which, however, its powers prove unequal, and the patient sinks, in defiance of the utmost exertions of human science and skill, into the inextricable grasp of death. Thus have I known a patient die from the puncture of a pin; thus have I seen another perish from exposing himself to cold when drunk:—ruddy, vigorous, and healthy a few days before, and suddenly becoming low, dispirited, anxious, and distressed, and being only relieved by the speedy and irresistible violence of "*the last enemy which shall be destroyed.*"

In considering the varieties and uses of the cellular texture, we are not either to attend solely to the larger parts, into the formation and connections of which it so obviously and essentially enters; but we must also study its finer and less obvious, but not less essential attachments. Such, for example, as it forms between the delicate and transparent membranes which enter into the arrangements of the eye; and the vessels which, by its assistance, so curiously

and securely permeate them, for the purpose of nourishing them, and the humors which they enclose and supply; and are thus enabled, with harmony and just proportion, for fifty, sixty, or an hundred years, and sometimes more, to fulfil their respective offices. So also the minutest fibrils in the small muscles which move the ossicula auditus are as much dependent upon it for their due connection to the adjoining ones, as the coarse and powerful glutei themselves.

It is unnecessary to multiply these remarks; but I hope this subject will be thought not unworthy of farther pursuit. I hope this Museum will, in time, contain a more perfect series of preparations of the various arrangements of the cellular texture, in every part of the body, which our hands can develope; first, as a requisite to all we can know or do in the natural state of it, and then in its alterations from disease. This is highly important to Surgery as a Science; and for discerning, describing, and promoting, that important

line of accurate investigation, for which Mr. Hunter's name will ever deserve that perpetual record and respect, of which these walls, as long as they subsist, will be the just and conspicuous memorial.

I know, gentlemen, that I have been considered, and in this I share the fate of other members of this Council, with whom it must be the honour of any one to be associated, as a partial and flattering eulogist of Mr. Hunter. But my partiality,—let the term, however, be properly understood,—my partiality has arisen from no personal feeling. I never had the pleasure and advantage, for I was then too young, and unknown, to enjoy the benefits of his personal acquaintance. I was not even his pupil at St. George's Hospital. But I saw him there; and I saw him also in cases of private practice that are deeply engraven on my memory; and some of which the preparations in this Museum revive, whenever I view them; and bring before my mind the countenance,—the mentality of the countenance,—of the man who was con-

sulted respecting them, and which made me look up to him as the greatest man of his time. For more than thirty years my sentiments have not been altered; and if I have been in any degree successful in my feeble endeavours to attain a respectable rank in my profession, it has been greatly owing to my observing the genius, and trying to follow the *scientific*, and at the same time, the *independent* course, which John Hunter pursued. Science indeed is always dependent on the truth of its own parts and relations; and the lawful interests of those who pursue it must be dependent on those for whose benefit it is employed. But their *minds* require independence, and not servility, with respect to each other. The diversity of impressions ultimately merges in the harmony of truths; nor need any honest, and candid, and upright investigator of fact, be ever jealous of others, on account of discrepancy in opinion. Light often issues from collision; and *we* have to explore recesses dark enough to be sometimes enlightened and directed, even by unexpected and startling gleams.

Haller places the *Tela Cellulosa* among the *Elementa Corporis*, as being one of the most universal fabrics distributed under the common integument, and as also constituting a chief part of the integument itself. But this latter assumption appears to have been hasty. He placed perhaps too much reliance on the confused appearances produced by putrefaction, without carefully enough watching that process through its different stages. Putrefaction, indeed, when accompanied by frequent ablution, is a great anatomist; but it cannot do much without the latter, which is its indispensable assistant; and we must watch its progress to ascertain its results, as we do that of the knife. It is however a fact that, during this process, by which so many parts are disentangled, their bonds of connection are dissolved, and are often thrown, perhaps, too heedlessly, away, in the stinking water in which it is usually accomplished; or elude us in the confusing and evaporative stages of disorganization and desiccation. To the progressions of this, more attention, anatomical, chemical, and physiological, is

much wanted; and as we advance in science, from the humble steps on which we at present stand, to a more commanding prospect, it must not be neglected. And let me be allowed to endeavour to impress on the minds of our students, and our younger members, that, when they are previously instructed in elementary principles, and, *after that*, begin soberly and philosophically to think for themselves, and to look around them, both for direct and reflected light, it is an object worthy of their sedulous attention to follow up this object, and trace it through all its progress, and that in the different parts of the body. It may not appear immediately to bear on our specific duties, but in minute anatomy it is one among many, many more, by which alone structure can be developed, and which are open to their toil, and demand it, during that period of quiet, and leisure, and disengagement from the cares of life, which is chiefly the lot of those who are beginning the practical part of their profession. Nay, it will not only afford them interest as philosophers, as physiologists, and as surgeons,

but will help to mould their minds to diligence, to discrimination, and to observation of facts, the effect of which will have a most beneficial influence on their habits, their facility of discerning, their promptitude, and, at the same time, their caution in judging, their firmness in acting, and their composure and accuracy in reflecting, that will amply repay them for all they have endured, and for all they have done.

One of the many curious and interesting circumstances in the natural history, if I may so speak, of the tela cellulosa, is its being the seat and path, every where, of the trunks of the blood-vessels, absorbents, and nerves, which ramify in it, as they subdivide for their respective destinations; so as every where to preserve the proper extent of their diameters; to secure them as much as their functions will admit from pressure *ab extra*, and that which might arise from causes within the frame; especially from the constantly varying contractions and relaxations of the muscles, and the flexions and straitenings again of

the joints. It holds the glands in their seats, whether they be large or minute, and connects the tough and inelastic periosteum to the hard bone underneath it. Adapted to all these uses, it is exposed to many chances of injury and disease, of some of which we shall hereafter have occasion to take cognizance; and I will repeat the hint I have already given to students in anatomy, to attend to all the varieties of this substance when they are dissecting; as to laxity and firmness, connection and use, in every part. Such an attention will make them more fully competent to those incisions which they may have to execute on the living body, where bleeding or other circumstances may so obscure the surfaces they cut, as, without this previous knowledge, occasionally to confuse them; and perhaps thus to produce all the differences between failure and success.

The importance both of a general contemplation and a particular examination of the substance in question, will be rendered still more evident, if we advert to some

of the peculiarities which it occasions in wounds, from the entrance of extraneous substances into it, especially those which are produced by gun-shot, to which its various degrees of yielding and resistance, and the different extent to which it dips down into the interstices of other more hard and regularly-shaped structures, unite to give to the path of such wounds, so varied, circuitous, and sometimes apparently fantastic a course. Now this is all regulated by fixed laws; and although we cannot, for want of a sufficient number of data, always know their combination, yet the surgeon who is well acquainted with the varieties the Tela Cellulosa assumes in the injured parts, will certainly possess more advantage in tracing their progress than one who has not at all, or only superficially attended to them; will often form a more correct judgment as to the actual lodgment of the wounding substance, and the propriety or the impropriety of searching after it, of leaving it, or of attempting its extraction; and of the suitableness and regulation of the subsequent treatment; so that

if it must remain, the best chance may be secured of its becoming hurtless, either by continuance or change of situation; or, finally, by the formation of an abscess, or by the ulcerative process, or the performance of an operation for its removal, at the fittest period, and under the most favourable circumstances.

Equally worthy of remark is the change of situation, and ultimate expulsion of narrow and pointed bodies, as needles and pins; often in their course moving through the Tela Cellulosa contrary to gravity, though doubtless in obedience to fixed laws, animal and mechanical; sometimes being long quiescent, and unthought of; at others being productive of the most severe and distressing symptoms, which cannot always be traced back to the time of their first penetration, notwithstanding the pain and irritation they excite, till they become disclosed by manifesting themselves externally, at parts remote from those at which they entered. Such was the case of a gentleman, who was distressed by violent

pains in the arm for about a year, for which no reason could be assigned. Sometimes they were considered as rheumatic, and at others as simply nervous, but yielded to no remedies. He went from one bathing-place to another, but all in vain. At length a spot appeared on the shoulder, and a needle made its appearance, upon the extraction of which all his symptoms ceased. But the most remarkable case, by far, of this nature, is that, an account of which has been lately sent me by my valuable friend, Baron Nicolay, Russian minister at Copenhagen; and which has been published by his Excellency's own physician, Professor Herholdt, and would almost exceed belief, were it not for the excellent character of the Doctor, and that it is certified by thirty-six of the most eminent medical men in that city and its vicinity. It occurred in a young Jewess, who began to feel colic pains, as they were thought, in the middle of August, 1807, which were much aggravated by a blow she received on the 3d of September, in the tumult excited during the siege of Copenhagen by the English army.

She continued afterward suffering almost every species of nervous torture and irritation. Epilepsy, hysteria, insanity, insensibility of body and mind, remittent fever, cough, dyspnœa, vomiting of blood, by turns assailed her. At length, after two intervals of tolerable health, one of two years' continuance, and another rather longer, on the 8th of January, 1819, more than eleven years from the first attack, a tumor formed near the navel, which was opened on the 12th of February, and a needle was extracted. Tumors formed afterward in different parts; and from that period to the 10th of August, 1820, two hundred and seventy-three needles were taken out, and she again recovered.* Af-

* From the right mamma,	22
between the mammæ,	14
the epigastric region,	41
the left hypochondrium,	19
the right	20
the umbilical region,	31
the loins,	56
the hypogastric and iliac regions,	64
the thighs and shoulders,	6
	273, besides

the subsequent hundred from the right shoulder.

terward she became ill again, and was affected, among other things, with diabetes, and a distinct limpid discharge from the vagina, so copious that Dr. Herholdt has not improperly called it *Diabetes Vaginalis.* In the space of 151 days, she drank 126 pints of fluid, chiefly water; and in that time voided 326 pints of urine, and 529 pints of the vaginal fluid; and from May, 1821, to July, 1822, an hundred more needles were taken, by incision, from an abscess in the axilla, and various places about the right shoulder. Dr. H. has promised to communicate the final result of the case, when this tragedy is ended.

It must be remembered that the cellular Tela is the chief residence of many diseases, and of many diseased structures of spontaneous origin; and when we consider that in this the muscles act, the vessels of natural structure and function subdivide, prior to their arrival and appointed distribution at their proper seats, we cannot be surprized that disorders here should produce unnatural actions, and, of course, unnatural, or

at least preternatural products; so as to confer additional importance on the study and the knowledge of the varieties of this texture, in the cognizance and discrimimination of all tumors, and in the performance of all operations.

This constitutes one of the most important demonstrations of the absolute necessity for practical dissection. It is not enough that parts should be seen in a theatre, cleared for demonstration, on account of distinctness; they must be traced by our own hands, and that with as careful an attention as possible to every circumstance. He who sees a muscle, or a blood-vessel, and does not know how to dissect it himself, is like the traveller who sees an object which attracts his attention, and which he learns indeed to recognize, but does not know how to find the way to it.

The facts I have adduced, however, show, that as even the most simple portions of the cellular membrane are, in consequence of the living principle, endued both with

their respective portions of tone and of irritability, they are therefore capable of entering into most, if not all of the organic changes and injuries of the parts they connect. And if, indeed, the powers of life appear in them, on some occasions, more feeble, and therefore more readily disposed to fall into a state of mortification and dissolution, this weakness is in a great degree compensated, in a vast number of instances, by the innate power given to the vessels which support it, to reproduce it when it has perished, by that exudation of coagulable lymph into which they readily enter for its new organization, and by other circumstances, which it will not be so much in place to enumerate here, as when we come to speak hereafter of the results of morbid and violent changes.

To sum up, then, gentlemen, the details of what I have laid before you, respecting the common integument, I will take a short retrospective view of the whole, by reversing the course I have hitherto pursued, and travel from within outward. I

have shown you that the cutaneous vessels having arrived, after their departure from the greater trunks, at the Cellular Tela, immediately underneath the Corium, there again ramify; and, after supplying the Tela with enough for its own support, and those portions which are to contain adeps, with the material for that secretion, they pass through the Corium, at very acute angles, permeate that substance, and anastomose on its outer surface, to form a tissue of vessels perfectly reticular, and having the most free and consentaneous communication with each other. From this reticulated arrangement proceed the villous projections, which combine the perspiratory and absorbent tubes. In this situation they are intimately connected with the papillæ, arising from nervous filaments, which enter the Corium somewhat in a similar manner, but subdivide within that substance, which holds the bases of the papillæ fast, and allows their conical points to project, so as to compose a texture conjoined with that of the blood-vessels, and of those which have the power of absorption. All these push on

their fine and delicate points into the interior Epidermis, which forms for them a soft and congenial resting place. Here the papillæ lodge in safety and healthful sensibility; and here the perspiratory vessels secrete their fluids, whether gaseous or aqueous, which finally escape through the living, and thin, but sure, and, under natural circumstances, inviolable cloak, formed by the velaminous and connected formation of the Cuticle, or exterior Epidermis; while in their course they nourish the capillular bulbs, both the sets of sebaceous glands, and are busily employed, at the same time, in the nourishment and repair of all the textures which support them. From within, they transmit materials that it would be noxious to retain; from without, they convey such as it must be important to receive. And if this beautiful adjustment and mutual dependence be disarranged, or impeded, or destroyed, who can reasonably wonder that diseases, formidable in their nature, though sometimes secret in their invasions, nay, even that death itself, should often unavoidably follow.

Here, Gentlemen, I must drop the present consideration of this subject; and perhaps I ought to apologize for having considered some parts of it so much at length. It is my intention, when we next meet, to request your attention to such remarks as I can make on the subject of Inflammation, and then to proceed to the consideration of its effects and its remedies. Not at all expecting to be carried so far as I have, I had projected and commenced an enquiry into the *morbid* anatomy of the skin, with which our pathology and our remedial assistance should begin; but a sudden, and long, and severe illness, which began soon after my appointment to this office, and the debilitating effects of which I still feel, proved a serious obstacle to the prosecution of my purpose. The time may, however, arrive, when I may be able, with more materials, and therefore with more satisfaction to myself, to speak to you upon it. At present, I feel that if there were time, I could not fully do so. It would be walking comparatively upon a *non tritum solum*, and must take more leisure to advance

on it safely, and consistently with this situation. I trust, however, I have entered, thus far, on a safe course of procedure; and should any of you go beyond me in it, you shall have my thanks, and not my envy, nor my opposition. *Hanc veniam petimus, damusque vicissim.* My view is in perfect harmony with that of the Council of this College;—to establish truth, not to cultivate private interest; but to let every member have his due allotment of opportunity of observation, and of fair fame; encouraged, and upheld, and assisted, and not impeded, by us, either as individuals, or as a body. There is enough for us all to do; and I will not, therefore, conclude this lecture, without a recital of those words of the first aphorism of Hippocrates, which were forty years ago indelibly impressed on my mind by an eminent physician, long since deceased: — "Ὁ Βιος βραχυς, ἡ δε Τεχνη μακρα, ὁ δε Καιρος οξυς, ἡ δε Πειρα σφαλερη, ἡ δε Κρισις χαλεπη." *Life is short, and art is long, and occasion sudden, and experiment dangerous, and judgment difficult.*—And how does the venerable sage conclude this sententious adage of simple and important truth?—

By an observation, which is in substance this—*It is therefore necessary to be prepared.* In this maxim of the Father of Medicine, let us see the wisdom and the necessity of uniting in sincere and honest efforts to alleviate, as far as possible, the afflictions of mankind; to promote the cure of their calamities; and, when this delightful object is placed beyond our expectations—to soothe the sufferings, to administer the consolations, and to diminish the anxieties, which may surround the bed, where prostrated strength and doubtful hope seek for relief and repose, or await the period of final dissolution.

The Author postpones, for the present, the publication of the Lectures on Inflammation and its consequences. But as he felt it right, in concluding, to allude to the present state of Surgery, and the failure of the application made, several years ago, by the College to Parliament, for some power to controul unauthorized practitioners, he has been strongly solicited by several of his friends, both in and out of the College, to take the present opportunity of publishing the following short Address, with which the Course was closed.

In the observations I have laid before you, Gentlemen, in the lectures for this season, for your indulgent attention to which, I beg you will accept my sincerest thanks, I am aware you must have observed many things which are trite and common; but I told you at first my object was not novelty, but truth,—not however trivial, but important truth. And I have been chiefly anxious to inculcate those established general principles, which ought to be always present to our minds, in the examination and treatment of most, if not of all, the diseases and injuries which occur in the various regions of a body, all of which are formed, supplied, and nourished by the same blood, conveyed and distributed by the instrumentality of one system of parts, modelled and relieved by another system, and controuled and regulated by a third. These views, therefore, are of universal moment, and of absolute necessity. Igno-

rance of them, or inattention to them, may lead to the most dangerous and frightful mistakes. How then shall I speak in terms of sufficient admiration of the abundant means which this metropolis affords to our students, of daily witnessing their exemplification, under the guidance and instruction of the most experienced and enlightened teachers. How can I sufficiently extol those Hospitals and Infirmaries, under whose charitable and protecting roofs, those who are afflicted by the severest injuries, and the most formidable diseases, are received, to enjoy the benefits of the highest professional learning and skill, the attentions of the most considerate humanity, and the advantages of religious counsel and consolation. We have also Dispensaries, (and to the learned College of Physicians was the country indebted for the origination of this most extensive and useful source of benefit to the poor and to the public, at a time of general sickness and distress). To these, patients in all stages of all illnesses are admitted to notice and relief, from the first hour of their occur-

rence, to the final period of their course; and this without separating the sufferer from those sources of domestic solace which are often to be derived from the solicitudes, and the affectionate attentions, that beam in countenances long familiarized by relationship, by habit, and by a mutual interest in the cares and the endearments of life. Thus, in many instances, affording to an anxious and tender partner in life, or to a dutiful child, the last melancholy satisfaction, to

> "Explore the wish, explain the asking eye,
> And keep awhile a parent (a wife—a husband) from the sky."

Have we not also, in addition to all these institutions, others for the express cognizance and relief of distinct diseases, and diseases of particular organs? I can assure you I have no wish to depreciate *these* below their real merits; and far be it from me to undervalue the learning, the science, the skill, the liberality, or the integrity, by which those who conduct some of them are conspicuously adorned:—men who count

it their honour to promulgate, as far as possible, the advantages which these funds of experience afford, and who are so truly qualified to render them available. Happy am I when these institutions, if they must exist, fall into the management of such meritorious and honourable persons. I must, however, be honest, and must candidly acknowledge, that however well these charities may be intended and conducted, and how liberally soever they may be supported, I cannot help fearing they have a real, although an undesigned tendency, to continue the ancient and fallacious prejudice, that manual dexterity (so valuable undoubtedly in itself), or the influence of some particular remedy, may dispense with the scientific guidance and controul of constitutional energies; to which no one can be made properly competent, but by a general education, and the study of general experience. Moreover, these establishments have one disadvantage, which, in my opinion, none of their advantages can sufficiently compensate. And it is this; — that they abstract from our Hospitals

and Dispensaries, and especially from the former, which must always be the chief, and indeed the only adequate resort of students for instruction, a large number of diseases, which occur in all places, and in every rank of society; and which, therefore, it is of deep importance to the public welfare, and the relief of mankind, that all Surgeons should have opportunities of knowing, and of studying. At these isolated institutions, a very small proportion only can attend ; and a youth coming from the country for the completion of his studies, and whose attendance in the hospital at which he enters, and on the requisite lectures, necessarily employs almost the whole of his time, cannot possibly go about from place to place, and from one institution to another, to see cases, which, if collected among others in his Hospital, he might, with his fellow-pupils, deliberately examine, without much additional labour or loss of time. So that he is obliged to return, or perhaps to go into the Navy, into the Army, or to the Colonies, comparatively uninstructed, except in theory, concern-

ing some of the most important and calamitous diseases that invade the happiness and well-being of mankind. I wish, however, that all separate establishments were under the superintendence of such able and excellent persons as those to whom I have alluded; but I fear there are too many of a very different complexion,—where secrecy, and not science,—where private interest, and not the public good, are the objects in view. Nor is even this the worst;—are not the covers of our magazines, and the columns of our newspapers, daily and weekly, loyal and disloyal, stuffed with nauseating advertisements, not only of secret remedies, but of secret practitioners,—men who are afraid to come forth to the light of an honest examination? Do not the houses in which their deceptions are carried on, with the most staring impudence, pollute our streets, by contrivances to decoy the unjudging and illiterate? Are not our fences and our walls, from the highest to the lowest, and down to the vilest corners, defaced with the mean and disgusting repetitions of their unaccredited

names?—"*Audacia hominum, qui nihil dum metuunt, audent omnia.*"—And we have no power to check it. We have indeed sought for this power, at its only legitimate and constitutional source, on the most public-spirited and disinterested terms; from no views to personal advantage, or to distinction, as a body, over other similar establishments in the empire. But we have been refused. Our motives were unfortunately misunderstood, and, of course, mis-stated; our conscientious concern for the public health was mistakenly construed into some selfish purpose; and powers that were conceded to the Company of Apothecaries, were denied to the Royal College of Surgeons. I complain not of the powers that have been conceded: I believe they have fallen into worthy and conscientious hands, and will assist in averting a part, at least, of an enormous evil from the community. But I trust I may respectfully complain, not indeed in the name, or on the behalf of this College,—I am neither inclined nor author-

ized to do so,—but in the name and on the behalf of my country, that more effectual means are not provided to repress the encroachments of ignorance and imposture. But I hope the time is approaching when a more just and liberal estimation will be formed of the character of this College. I hope we shall appear as supplicants, on this subject, no more. I trust our enlightened and beneficent Legislators and Governors will, ere long, perceive the expediency, and even the necessity, of confiding to us some authoritative controul, by which they, through our means, may preserve lives from being wantonly and wickedly endangered; and property, often scanty and hard-earned property, from being basely and deceitfully extorted. But, however this shall be, let quackery stalk abroad as it may,—let self-interest and artifice creep about, as they will, it always has been, and always will be, the constant determination of the members of the Council of this College, and of those Professors who address you under their sanction, that

neither from this chair, nor from their own separate schools, shall any thing be ever recommended, as deserving the regard of our members and our students, or the countenance of the public, but SOUND PRINCIPLES, CONSISTENT PRACTICE, and UNBLEMISHED HONOUR.

EXPLANATION OF THE PLATES.

Plate I. *fig.* 1. is a representation of two portions of the *cuticle*, or *exterior epidermis*, magnified 12 times. It illustrates the *rugæ*, or natural wrinkles, and the corresponding ridges, or *bands* of the cuticle; and also the *capilluli*, with their bulbs, which passing obliquely through the rugæ, serve as fastenings, securing the union of the cuticle and of the *interior epidermis*, or *rete mucosum*, to the cutis. This figure is particularly referred to (by mistake as fig. 3.) at page 131, and, together with the others in this plate, at page 194.

Fig. 2. exhibits the *bulbs of the capilluli* in profile, magnified 60 times.

Fig. 3. A hair, with its *bulb*, extracted from the leg of an adult, and magnified 400 times; the light being concentrated upon it, and shining through it. See page 191.

Plate II. explains the proper structures of the *cuticle*, or *exterior epidermis*, and of the *rete mucosum*, or *interior epidermis ;* demonstrating that there are no *pores*, or regular perforations through either of these integuments. This plate is referred to at page 134.

Fig. 1. is a drawing of a minute portion of very thin cuticle from the lip. It is represented as seen in a recent state, through a lens magnifying 40 times, the light being reflected through. It appears a *woolly* or *bibulous* texture, traversed by darker lines, where it is partially cracked, but nowhere regularly perforated or porous.

Fig. 2. represents a very minute portion of the cuticle of the arm, dried, and magnified 160 times, under the same circumstances as that from the lip, and that of which the next figure is a drawing.

Fig. 3. is the representation of a still more minute portion of the exterior epidermis, taken from the arm, dried, and magnified 400 times. This, and the last figure, confirm the facts demonstrated by the first on this plate.

Fig. 4. is the appearance of a minute portion of thick cuticle from the tip of the thumb, dried, and magnified 240 times; the light reflected from above as well as from below, upon the object, of which the external surface is here shown. The

interior epidermis (which was removed from the portions of cuticle represented in the three former figures) is still adherent to this, except at the angle b d e: and the dark lines a b, c d e, f g, and h i, exhibit the furrows or rugæ of the cuticle which covers the palm of the hand when examined as above described.

Fig. 5. is the reverse of the last. It exhibits the bands or ridges a b, c d e, f g, and h i, corresponding severally to the furrows shewn in the last figure; and it exhibits the *velamina*, or cells of the interior epidermis, which is of a fibrous and bibulous texture, like that of the exterior, but much softer. At the angle b d e, is to be observed the cut surface of the cuticle, which was at this part split for the purpose of removing the interior epidermis, and of contrasting with it the fibrous and bibulous, or velaminous texture of the exterior.

Fig. 6. In this drawing, the two surfaces of the cuticle represented in the last figures, are drawn as they appear to the naked eye, with the light shining through.

It may here be observed, that the cuticle and the interior epidermis, when viewed through the miscroscope with a sufficiently powerful lens, never put on any other appearances than those which are represented in this plate; excepting,

first, when too strong a light is reflected through them directly towards the eye; in which case they appear transparent, or simply as a film (see Plate iii. figs. 1. and 2.); and, secondly, when, from a similar cause, the prismatic colours produced in all parts of the object, sufficiently prove the regular tetrafoil, or catenary, or other form which they may assume, to be an optical deception. See Plate iv. figs. 2. 3. and 4., and Plates iii. iv. and v. in confirmation of the facts here proved.

Plate III. demonstrates the existence, form, and locality of the *inter epidermal glands.* It is referred to at page 184.

Fig. 1. exhibits several of these bodies as they appear on the internal surface of the moist cuticle, after it has been long macerated in water. One pear-shaped body is to be seen, on the left *of the figure*, which is *a bulb of a capillulus* in perspective, under a lens magnifying 240 times.

Fig. 2. At the lower part of this figure the interior epidermis is represented upon the cuticle as in fig. 5. plate ii. The interior epidermis (the cuticle being torn from under it) is seen alone at one part, and at the other the exterior epidermis alone is exhibited; the interior being stripped off to shew the *glands*, which are thus

demonstrated to be *inter-epidermal*, was magnified 60 times.

Fig. 3. is a representation of the *inter-epidermal glands* (and of three bulbs of capilluli) *seen in profile*, in a moist state, with a lateral light, and through a glass magnifying 60 times.

In plate ii. fig. 2. some of these glands, and one bulb of a capillulus in perspective, are represented as they appear when *dried*.

Fig. 4. exhibits the internal surface of the moist interior epidermis in profile; confirming the fact demonstrated in figure 2., viz. that these bodies are exclusively *inter*-epidermal. The objects represented in this, and in the next figure, were magnified 60 times, under a lateral light.

Fig. 5. is a view of the external surface of the moist interior epidermis, in profile. This shews the original object (which was casually taken from a considerable number of portions of the interior epidermis) to have been deprived, in its separation from the cuticle, of the inter-epidermal glands; and demonstrates the stronger attachment that these glands have to the exterior epidermis than to the interior, when the two are torn asunder.

Fig. 6. is a representation of the bodies long known as the *sebaceous glands of the common*

integument, as seen by the naked eye, being morbidly enlarged from an excessive quantity of their natural secretion retained in their ducts. The two epidermides have here been removed, and in one or two places these glands have escaped, so that the deep niduli, in which they were set in the cutis vera, are shewn in the figure.

Fig. 7. is a view of the same *sebaceous glands*, represented of their natural size, and appearing as small specks, situated upon *the cutis vera*, in which they are seen to be partially or entirely imbedded, on the surface of the nose and upper lip, where the two epidermides are both torn up. Where the cuticle passes an angle in the cutis, as at the edge of the lips and nostrils, &c. both epidermides invariably adhere with peculiar firmness.

Plate IV. *fig.* 1. shews the internal surface of the hard cuticle of a labouring man's hand, separated by long maceration from the interior epidermis (which is here very thin, and very strongly adherent), and afterwards dried upon blue paper, and magnified nine times. The inter-epidermal glands are to be counted by the naked eye in the preparation from which this drawing is taken: and about *one hundred and*

thirty of them are found in the surface of one twenty-fourth part of a square inch, disposed in rows, and lying in the furrows, which are the reverse of those minute ridges observable upon the external palmar surface of the adult hand. Many of the glands are lost; those that remain appearing in the preparation (magnified six times) like broken rows of pearls. An equal number of *the orifices of their ducts*, are similarly disposed in the same space, and to be counted with a magnifying-glass on any adult hand. See Plate v. fig. 2.

Fig. 2. represents a minute portion of moist cuticle, from the sole of *the foot of a fetus*, distended on a black surface. It appears in the drawing as when magnified 60 or 80 times, and, in these particulars, corresponds with the two figures next following.

Fig. 3. is a portion of cuticle from which nearly all the inter-epidermal glands have been accidentally wiped off in cleaning it with a camel-hair pencil, to which they adhered like minute beads, too minute to be counted, but visible to the naked eye. The *niduli* of these glands, or *origins* of their ducts, are seen in this figure; these ducts pass very obliquely to the surface of the cuticle, and they are the only perforations discoverable in it.

Fig. 4. exhibits the terminations, or *orifices* of the *ducts* of the inter-epidermal glands, in the sole of the foot of a fetus. The ducts of these glands have been long observed, and hitherto they have been supposed to be pores, and the exit of the perspiration. (See Plate v. figs. 1. and 2.)

Fig. 5. is a drawing of the internal surface of nearly the whole of the cuticle of the thumb of an infant at birth. The inter-epidermal glands are here seen to be equally dispersed over the back of the thumb, but arranged in rows on the palmar surface.

Plate V. *fig.* 1. exhibits the inter-epidermal glands on the palmar surface of the extreme joint, or phalanx of the finger of a fetus, as seen when the cuticle of this part is everted, filled with black varnish, and magnified eight times. Not all the glands are shewn in this figure, as they are too numerous, and too regularly disposed along the furrows throughout the whole surface, to have been represented without confusion. In the centre and at one corner they are drawn precisely as they are in the preparation, along every single furrow.

Fig. 2. is a view of the natural size of the external surface of an adult thumb; it may be considered as the reverse of the last figure,

exhibiting the *orifices of the ducts* of the inter-epidermal glands, as these glands themselves are there exhibited. The human perspiration is of so unctuous a nature that it will occasionally produce the same effect upon the lithographic stone as the ink with which some parts of these drawings are made; and the *impression* of the thumb, though invisible till the ink is applied for printing, will occasionally print black. It is always found, if when the hand is only moderately warm, it be impressed on glass, that the stain of the perspiration is left on the glass everywhere, EXCEPT *at the orifices of the ducts of the inter-epidermal glands;* the glass being wholly unobscured only where *these orifices* have been applied.

For these reasons it was thought, that an impression of the thumb (*by means of the perspiration alone*) might have been obtained so as clearly to demonstrate that these *orifices* are unconnected with the proper perspiration; but the number of copies, and the distinctness requisite in every one, are too great to allow of this being accomplished; *fig.* 2. is therefore a copy of a stamp or impression of the thumb when blacked with the lithographic ink; and the orifices in this figure shewn black, are those points which will be found less or not at all discoloured, in

the impression of the thumb, moderately warm, upon a piece of clear glass.

Fig. 3. shows the bulbs of the capilluli transfixing the ridges, and the inter-epidermal glands lying in the concavities or velamina of the cuticle of an infant's back, seen from its internal surface. These glands are distributed here irregularly, not differing in size, and many of them hidden by the bulbs.

Fig. 4. The preparation represented by this figure is the reverse of the last; the *bulbs* and the *glands* appear as white spots; the former of a larger size, the latter of a smaller.

Fig. 5. The internal surface of the cuticle of an infant's scrotum, with the bulbs of five capilluli, or immature capilli. The glands here vary much as to their magnitude. This and the two preceding views are magnified nine times.

Fig. 6. The inter-epidermal glands of the perineum of an infant magnified 20 times; they are about equal in size, very irregularly disposed.

Fig. 7. A piece of skin enormously distended from the abdomen of a dropsical subject, magnified 18 times. At the upper part are represented four orifices, by some called *the Pores of the Cutis;* viz. one on the left of the figure; a second (from which a capillulus is almost completely drawn out upon a piece of black paper),

and a third, and a fourth, on the right of the drawing, which correspond to the bulbs of two capilluli below. At the lower part of this drawing are shewn the folds of the extended cuticle and interior epidermis, which have been stripped off from the surface of the cutis vera above; and which exhibit the bulbs of eight capilluli, to every one of which an orifice (like those four above mentioned) correspond; as is seen in four of them, under two of which small pieces of black bristle are placed. That there are not to be found on the human cutis any orifices, or pores, nor regular perforations, besides those which have contained capilluli, or capilli, or sebaceous glands long known as such, was proved in one most satisfactory preparation, exhibited at the College when these lectures were delivered, but since unfortunately lost, and most difficult to be replaced. That from which this figure was taken was too delicate for preservation; but the facts here stated are sufficiently verified by others deposited in the Hunterian Collection, and they are confirmed by *fig.* 7. and 6. Plate VII., which exhibit the natural foramina or niduli of the bulbs of the hog's bristles as they are seen pierced through the tanned skin of this animal.

Plate VI. *fig.* 1. A small portion of the hu-

man cutis injected, dried, varnished, and magnified 6 times. This figure shews the trunks of those minute branches of blood-vessels which transfix the corium to form its vascular surface.

Fig. 2. The more minute ramifications of the arteries of the human cutis are here portrayed, more superficial than those in the last figure, as to situation.

Fig. 3. The helix or outer rim of this dried ear continues the illustration begun in the last two figures.

Fig. 4. On the helix of the ear, represented in this figure, the blood-vessels are seen so minutely ramified as to form a complete net-work or covering to the Corium, with the penicillated perspiratory vessels arising from it. Perhaps this is the most minute and successful injection of the cutis that has ever been made.

Fig. 5. represents a portion of the cutis from the back of a child. Where the glare of the varnish does not obscure the surface, the same coat of vascular convolutions may be seen as in the last figure.

Plate VII. *fig.* 1. represents a piece of common *soft doe-leather*, magnified 4 times; as are the first seven figures on this plate. This shews the prepared leather to consist of a

purely *fibrous* texture, the fibres curling in every direction.

Fig. 2. represents the section of a piece of *horse-leather*. In it there appears *a granular or parenchymatous substance* interposed between the fibres.

Fig. 3. represents a piece of *human skin*, in which the *granular substance* is changed (by long maceration in water) into adipocere, being yet retained in *the fibrous or membranous texture*, and supported by it; so as to prove the existence of both in the human corium.

Fig. 4. The *external surface* of a portion of the human cutis tanned. It exhibits the furrows and niduli of the bulbs of the capilluli; and at the upper corner, on the part of the figure next to *fig.* 5., the surface of the section much resembles that of horse-leather, being however far finer.

Fig. 5. represents the *flocculated internal surface* of a piece of *human cutis tanned;* and at its upper part the surface of its section is exposed.

Fig. 6. The *internal surface* of a piece of *hog-leather*, shewing how it is completely pierced through by the niduli or rather foramina of the bulbs of the bristles.

Fig. 7. The *external surface* of a piece of *hog-leather*, in which the *papillæ* (visible to the naked

eye in the preparation) are very clearly distinguishable, all pointing downwards.

Fig. 8. This is the appearance of a preparation of an ulcer from the leg of an adult. At the upper part, and above the ulcerated surface the *papillæ* of the cutis are seen morbidly enlarged, but not otherwise diseased; and the cuticle and interior epidermis, stripped from these *papillæ*, hang down from their lower margin, exhibiting the cells or *velamina* in which they have been lodged. Behind this pendulous portion of the epidermides the ulcerated surface is portrayed, covered with a flocculent layer of coagulable lymph.

Fig. 9. represents a portion of human cutis, preternaturally enlarged to an enormous extent and degree, from the foot of an adult. The immense thickness of the *corium* is observable in the section at the upper part; and the enlarged *papillæ* are shewn over the rest of the drawing, except at one spot, at the top of the figure, where a desquamated flocculus of the moist cuticle still adheres. See the portrait of the female from whom this preparation is taken, in the Hunterian Museum at the Royal College of Surgeons. This and the last figures are referred to at page 170, and this at page 209.

It may not be improper here to state that LITHOGRAPHY (besides that it appears in general the most eligible mode of publishing anatomical representations) is the only mean whereby a sufficient number of several figures in these plates, could have been struck off, for a single edition of this work; nor would the Art of Lithography have answered this end, nearly so well, if at all, before the late very important improvements in its application, for which we are indebted to Mr. Hullmandel, of Great Marlborough Street, London.

The preparations deposited in the College Museum, illustrative of the facts here described, are best seen with a *double lens*, magnifying eight times.

THE END.

London:
Printed by A. & R. Spottiswoode,
New-Street-Square.

Plate 1

Fig: 1.

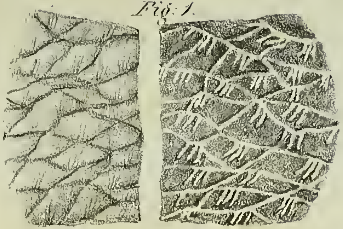


Fig: 2.

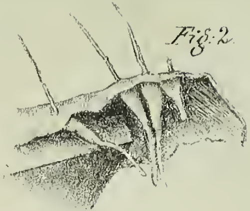
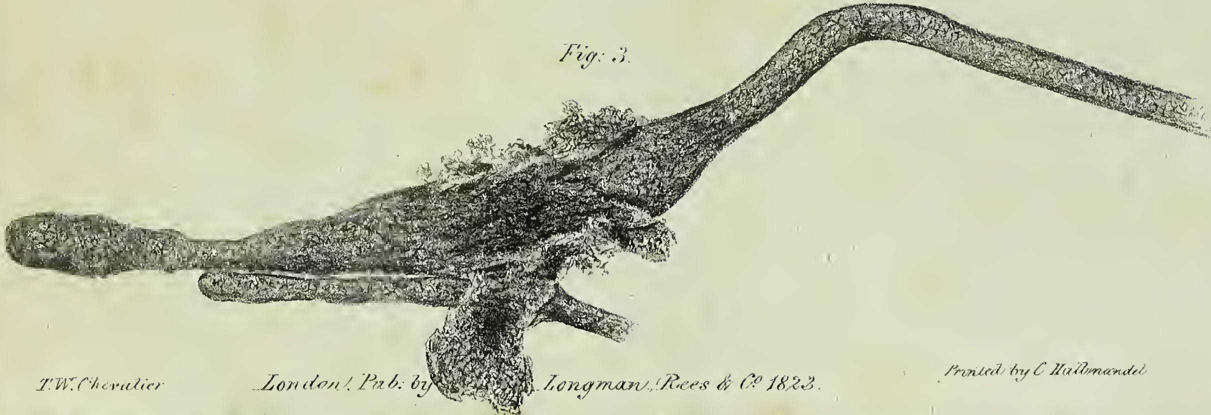


Fig: 3.

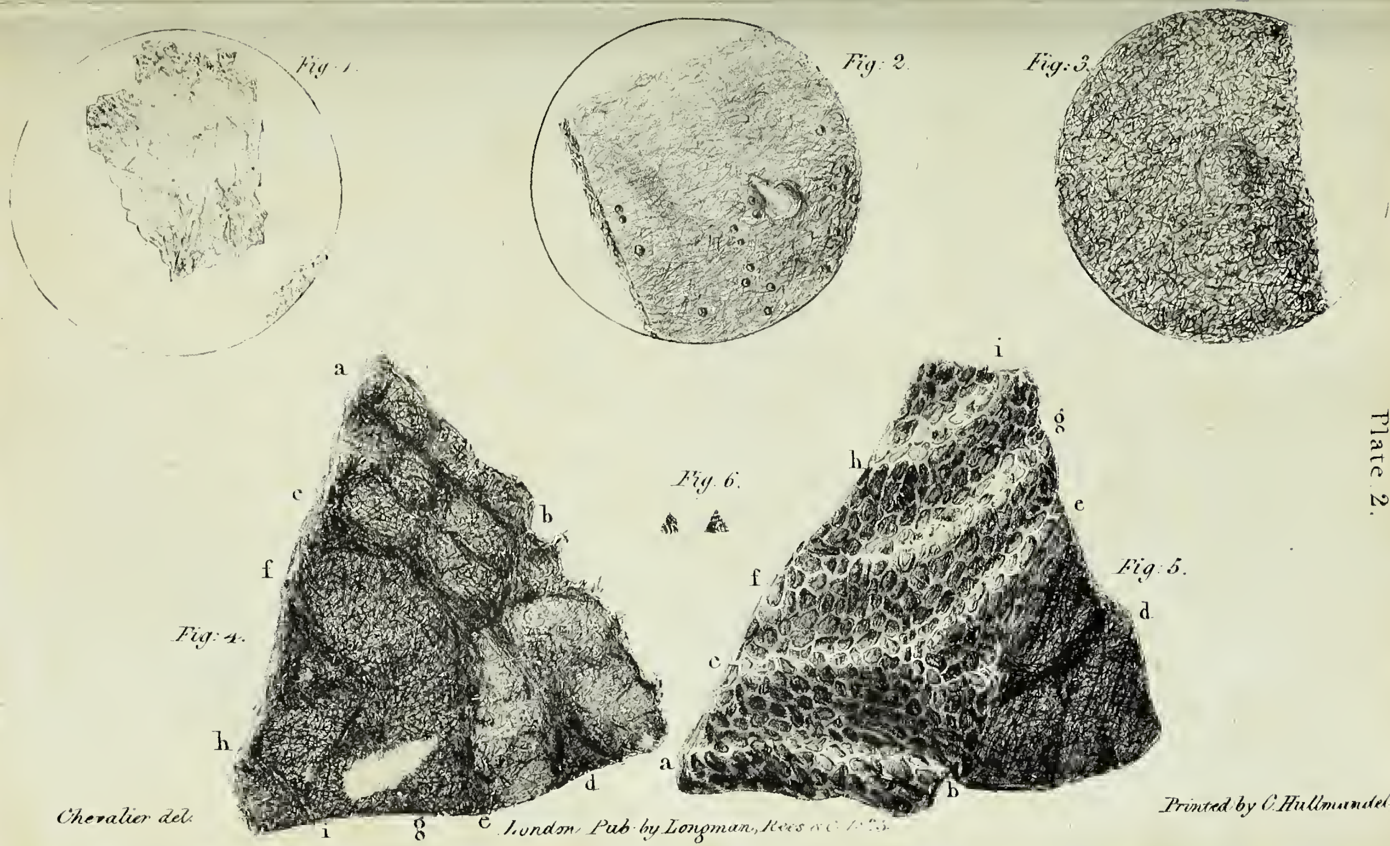


T. W. Chevalier

London, Pub: by Longman, Rees & Co 1823.

Printed by C. Hullmandel

Plate 2.



Chevalier del.

London. Pub. by Longman, Rees & C.

Printed by C. Hullmandel

Plate 3

Fig: 1.

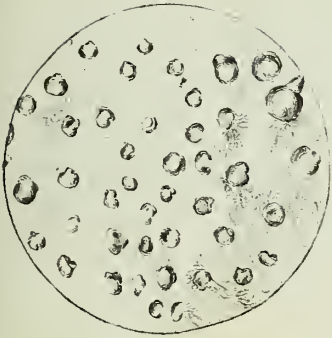


Fig: 2.

Fig: 3.

Fig: 4.

Fig: 5.

Fig: 6.

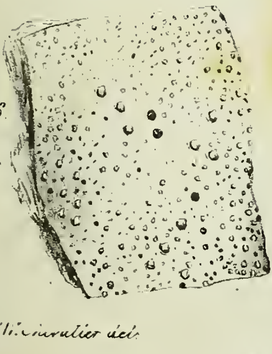


Fig: 7

T. Chevalier del.

Printed by C. Hullmandel

London. Pub.d by Longman, Rees & Co. Oct.r 1823.

Plate 4.

Fig 1.

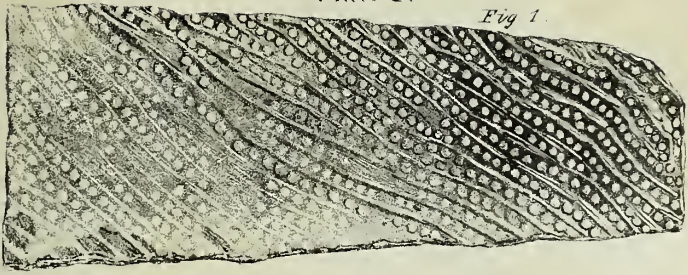


Fig: 2.

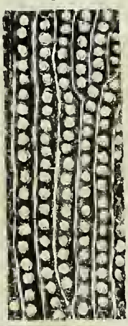


Fig 3

Fig: 4.

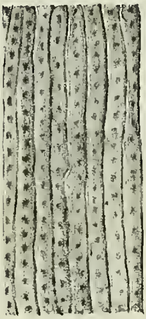
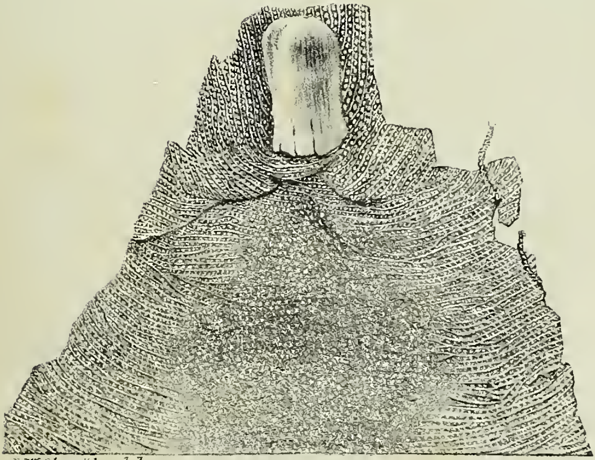


Fig: 5.



F. W. Chevalier del. Printed by C. Hullmandel

London. Pub.d by Longman, Rees & Co 1823

Plate 5.

Fig: 1.

Fig: 2.

Fig: 3.

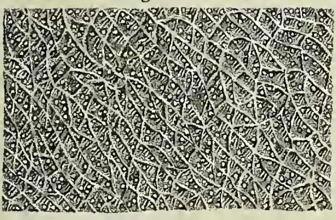


Fig: 4.

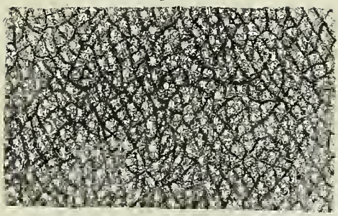


Fig: 5.

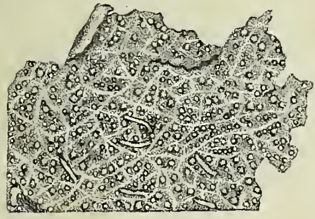


Fig: 6.

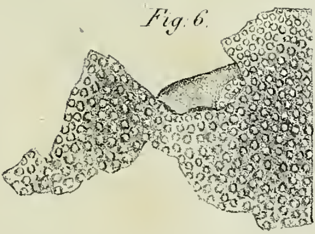


Fig: 7.

T W Chevalier del.

Printed by C. Hullmandel.

London. Pub. by Longman, Rees & Co. Octr. 1823.

Plate 6.

Fig. 1.

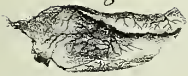


Fig. 2.

Fig. 3

Fig. 4.

Fig. 5.

W Chevalier del. *Printed by C. Hullmandel.*

London. Pub. by Longman & Co. Octr. 1823

Plate 7.

Fig: 1.

Fig: 2.

Fig: 3.

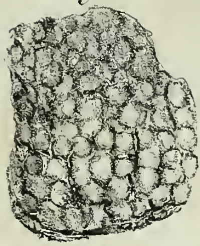


Fig: 4.

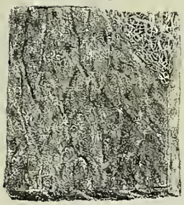


Fig: 5

Fig: 6.

Fig: 7.

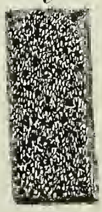


Fig: 8.

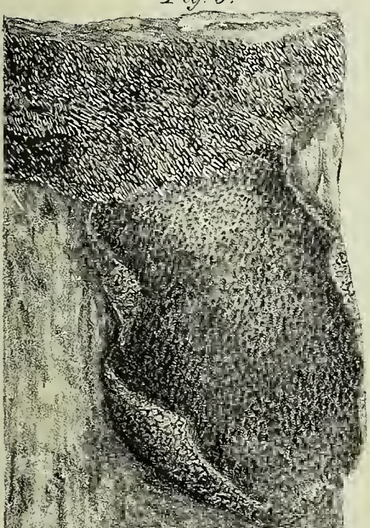


Fig: 9.

T. W. Chevalier del.

Printed by C. Hallmandel.

London. Pub.d by Longman, Rees & Co. 1823.

EXPERIMENTAL RESEARCHES

ON THE INFLUENCE EXERCISED BY

ATMOSPHERIC PRESSURE

UPON THE

PROGRESSION OF THE BLOOD IN THE VEINS,

UPON THAT FUNCTION CALLED

ABSORPTION,

AND UPON

THE PREVENTION AND CURE OF THE SYMPTOMS CAUSED BY THE BITES

OF

RABID OR VENOMOUS ANIMALS.

(DEDICATED BY PERMISSION TO HIS MAJESTY.)

WITH

AN APPENDIX,

CONTAINING

THE ORIGINAL REPORTS OF BARON CUVIER AND OF PROFESSORS DUMERIL AND LAENNEC, TO THE ROYAL INSTITUTE OF FRANCE, AND TO THE ROYAL ACADEMY OF MEDICINE OF PARIS, &c. &c.

BY

DAVID BARRY, M.D.

KNIGHT OF THE ORDER OF THE TOWER AND SWORD, MEMBER OF THE ROYAL COLLEGE OF PHYSICIANS IN LONDON, FIRST SURGEON TO THE PORTUGUESE ARMY, SURGEON TO THE FORCES, *&c. &c.*

" Habemus etiam et vivaria pro bestiis et avibus omnigenis,—
Experimentum etiam sumimus super illas venenorum omnium
et antidotorum—Ut corpori humano melius caveamus."—

BACON. *Nova Atlantis.*

LONDON:

PRINTED FOR THOMAS AND GEORGE UNDERWOOD,

32, FLEET-STREET.

MDCCCXXVI.

CONTENTS.

APPENDIX.

DEDICATION.

TO THE KING'S MOST EXCELLENT MAJESTY.

SIRE,

If to the proud consciousness of being one of that people which your Majesty's wisdom has rendered so pre-eminent in Arts, in Arms, and in Commerce; the work now humbly offered to your Most Gracious Majesty's protection, shall entitle its author to add that of having diminished the amount of human evils by increasing the stock of human knowledge, the highest ambition will be gratified, and the utmost labour rewarded of,

Sire,

Your Majesty's

Most humble Servant,

And dutiful Subject,

DAVID BARRY,

Surgeon to Your Majesty's Forces.

PREFACE.

The first of the two Essays contained in this volume is composed from Notes of a Memoir *On the Motion of the Blood in the Veins,* which I had the honour of reading before the Academy of Sciences at Paris, on the 8th of June, 1825—and to it is annexed a translation of the Report made to the Institute of France, by Baron Cuvier and Professor Dumeril, who were appointed to witness a repetition of the experiments, and to examine the said Memoir.

The Second Essay, a corollary to the first, had for its basis a short note read by me before the French Academy of Medicine, on the subject of External Absorption.

And the Appendix contains copies of certain original documents referred to in the preceding pages.

I feel that it would be quite impossible for me to give an adequate notion of the liberality and disinterested kindness with which the leading men of science in Paris received my communications, or of the facilities which they afforded me not only to bring them forward, but to prosecute

and repeat the inquiries and experiments necessary to their elucidation.

After I had read the first Memoir, Professor Laennec procured for me the permission, as well as the entire means, to repeat my experiments at the School of Medicine. In him I found the assistance of consummate anatomical and physiological science, with the high-minded zeal of liberal friendship.

M. Dumeril also, in the handsomest manner, furnished me with the means of again repeating the experiments in presence of himself, the Baron Cuvier, Professors Laennec, Cruvelhier, Billery, Breschet, Edwards, and many other distinguished persons.

Baron Cuvier, to the honour he conferred upon me by being present at my experiments, generously added that of placing at my disposal every thing necessary to prosecute my investigations at the Royal Garden of Plants, an establishment which has already ensured with posterity immortal honour to him, and to the nation of which he is so distinguished an ornament.

The letter of M. Girard*, director of the Veterinary School at Alfort, will show with what noble zeal the science of physiology is cultivated in France. In England, on the contrary, an outcry has been raised of late, not entirely unsup-

* See Appendix, No II.

ported by some leading professional men, against every thing like inquiry, having for its basis *direct experiment upon living animals.* Yet the little that we know of the laws of life is drawn from this source alone.

The examination of a quiescent machine can only *suggest* the use of its parts when they were all in movement. Well-directed experiment upon these same parts, actively employed in fulfilling their various functions, either confirms the suggestion, giving it the validity of a law, or at once destroys the whole fabric of a baseless theory.

" *Unicum sæpe experimentum, integrorum annorum laboriosa figmenta refutavit* *."

The wisest and the most virtuous men of the ages they lived in spent a large portion of their time in making experiments upon living animals. Those of Harvey were honoured by the presence of his sovereign, who, by that act alone, would have been entitled to a share of the immortality gained by the illustrious discoverer of the circulation †.

Those who have stated that Harvey made but few experiments, and that to these few we owe

* Haller, Tom. i. Præf.

† " In jugulari venâ internâ denudatâ damæ vivæ (coram multis nobilibus, et rege serenissimo domino meo, assistentibus) per medium divisa et abrupta," &c.—HARVEY, *De Circ. Sang.*

but little, should have read his works. In these they would have learned, that an unlimited supply of animals was placed at his disposal, by the enlightened prince to whom he was physician. His own words are singularly applicable to these candidates for unscientific popularity,—"*Qui nihil nisi homines secant.*"

Bacon (Lord Verulam), whose stupendous powers of mind have never, perhaps, been equalled, in drawing a picture of what an institution or university ought to be, in order to afford the fullest opportunities for acquiring useful and exalted knowledge, puts the following words into the mouth of one of the *patres domûs Salamonis,* in his *Nova Atlantis.*

"Habemus etiam septa et vivaria pro bestiis et avibus omnigenis, quibus, non tam propter novitatem et raritatem, quam ad dissectiones et experimenta anatomica utimur; ut ab iis, quid fieri possit circa corpus humanum lucem accipiamus. Veluti vitæ, in iis continuationem, licet nonnullæ partes quas vos pro vitalibus habetis perierint, aut extractæ fuerint. Resuscitationem nonnullorum, quæ specie tenus, mortuæ erant. Experimentum etiam sumimus super illas, venenorum omnium et antidotorum, et aliorum medicamentorum, tam chirurgicorum, quam medicinalium, ut corpori humano melius caveamus."

Haller, who was a senator and a minister in his native country, and not less remarkable for the

benevolence and integrity of his character, than for his profound researches into the laws of life, says, in the preface to his great work on Physiology, " Dissecanda ergo animalia, verum minime sufficerit cadavera dissecuisse, viva incidisse necesse est. A cadavere motus abest, omnem ergo motum in vivo animale speculari oportet; sed in motu animati corporis interno et externo, tota physiologia versatur. Ergo ad sanguinis circuitum, ad ejus subtiliores motus perspiciendos, ad respirationem, ad intestinorum reptatum, ad chyli iter intelligendum, absque vivorum animantium strage, nihil omnino profici potest."

They who inveigh most loudly against experiments upon living animals, and who affect an excess of sensibility, have never made any experiments themselves. They are contented with the exposition of what they, in their wisdom, suppose nature *ought* to do, instead of investigating what she actually does.

Others talk of needless cruelty. If any useful knowledge is to be obtained by an experiment, none of the means necessary to arrive at this knowledge can be needless, and none else can be adopted without defeating the purpose aimed at; therefore, in useful experiments, there never is needless cruelty, or, in other words, unnecessary pain inflicted.

When medical men are praised at public meetings, and their letters there read with applause,

in which they profess the determination, neither to open the living book of animal nature themselves, nor permit it to be opened by the youth committed to their charge, our best feelings are allowed to take a very wrong direction. There are those, however, who have had the candour and the honesty to assert in the face of this vulgar clamour, that we have as good a right to make animal life subservient to the increase of our useful knowledge, as of our bodily strength and amusements. This is plain common sense, and must in the end prevail. One word as to the essays and experiments.

A vague unauthenticated notion, that the return of the black blood to the heart is, in some undefined way, *influenced* by suction, may be traced as far back as the time of Harvey. Haller, and many others also, noticed a marked coincidence between the respiratory movements of the thorax in the warm-blooded mammalia, and the motion of their venous blood. But the mechanism was never pointed out, by which nature, in these animals, applies the mighty agency of atmospheric pressure to the veins, and connects, as cause and effect, the expansion of the chest with the afflux of the centriptal fluids to the heart. The experiments, therefore, that demonstrate this mechanism, and supply these important desiderata in physiology, must be entitled to the meed of novelty, along with whatever other merits they may possess.

The first experiment, p. 10, however nearly it might have been approached, was never made; that upon the pericardium, p. 19, was never even imagined by any man living or dead, before me. Whether my conclusions be just or new must be soon decided—in the mean time, as the most intense power of the reasoning faculties of man can never arrive at a discovery so perfectly original, as to be entirely unconnected with every thing that was known or suggested before, I shall reply to those who deny the originality of my researches in the words of the great Haller.

"Præterea æquo animo oportet expendisse, non eum verum inventorem esse, cui vaga aliqua cogitatio elapsa est, in nullo fundata experimento, sed eum omnino eam laudem mereri, qui verum ex suis fontibus, per sua pericula, suasque meditationes, eruerit, et adeo firmis rationibus stabiliverit, ut veri cupidos convincerit."—*Haller*, tom. i. lib. 3.

D. Barry.

Paris, March 24, 1826.

ERRATA.

Page 19, line 15, *for* *x*yphoid *read* *x*iphoid.
30, „ 11, *for* cavas *read* cavæ
37, „ 14, *for* subclavi*on* *read* subclavi*an.*
141, „ 8, osse*sus* *read* osse*ous.*

N. B. The details introduced into the text at p. 28, relative to the experiments performed at Professor Coleman's on the 10th of February last, were intended for, and ought of course to have appeared as a *note*, as they formed no part of the original Memoir.

PART I.

MEMOIR ON THE MOTION OF THE BLOOD IN THE VEINS.

Read by the Author, before the Academy of Sciences, on the 8th of June, 1825, *at the Institute of France.*

OBJECT OF THE MEMOIR.

The object of the following Memoir, is to demonstrate by proofs, drawn from the anatomical structure of animals and from direct experiment,

First. The powers by which the blood is propelled through the veins to the heart.

Secondly. The comparative velocity with which it is moved through the veins, and through the arteries.

Thirdly. That the constant supply of blood to the heart, cannot depend solely upon the causes to which it has been hitherto ascribed.

What is the amount of all that has been hitherto proved, relative to the Circulation of the Blood?

We owe to the sagacity of the immortal Harvey our knowledge of this incontrovertible fact, that the blood in the living animal is in constant circulation from the ventricles through the arteries and veins, to the heart again, where it is to receive a fresh impulse.

Harvey not having been able, either by dissection or experiment, to discover any other power actively and constantly employed in propelling the blood along this course, assigned the whole task to the heart alone. The reasonings and the experiments which he adduced in illustration of this doctrine, clearly prove that the circulating current takes the direction which he had already pointed out, but certainly do not rigorously demonstrate that the heart is the sole impellent power.

Later physiologists have done but little to shew either the truth or the error of Harvey's assertions. They have merely admitted a few secondary sources of impulse to the blood; such as—

1. The contractile power of the arteries, whether the effect of muscular or elastic fibres. 2. The insensible contraction of the capillaries, supposed to be independent of the heart. 3. The action of the veins themselves upon their contents. 4. The pressure of muscles of voluntary and involuntary motion.

Of these supposed powers, some are so little susceptible of being demonstrated by direct experiment, others must be so uncertain in their operation, and the theories which they have been brought to support are so opposed to each other, that the evidence against is, *à priori*, nearly as strong as that in favour of their existence.

The supposition that the cavities of the heart possess the power of dilating themselves, and therefore of acting alternately as suction and forcing-pumps, although adopted by some existing physiologists, has hitherto derived but little support either from anatomy or experiment. *This opinion was too trite, even in the days of Harvey,

* "Neque verum est similiter quod vulgo creditur, cor, ullo suo motu aut distensione, sanguinem in ventriculis attrahere, dum enim movetur expellit, &c.—Harvey *de Motu Cordis*, cap. ii.

to merit serious refutation. Neither the auricle nor the ventricle appears to be furnished with any intelligible muscular apparatus, by which either can accomplish its own dilatation. Every thing we find in them seems evidently calculated to favour their contraction.

The doctrine of the active resiliency of the lungs, tending constantly to leave a vacuum between their surface and the parietes of the thorax, and thereby assisting to bring uninterrupted atmospheric pressure upon the blood in the veins, was, I believe, first broached by Dr. Carson, of Liverpool, in 1815. Being, however, purely theoretical, and unsupported by direct experiment, it seems, notwithstanding its ingenuity, to have made but little impression, for although published now ten years, I do not find it alluded to in the lectures or the writings of the French physiologists.

The amount, then, of all that has been hitherto proved, and of which there is any thing like material evidence relative to the circulation of the blood, may be found in this short sentence, written nearly two hundred years ago.

"*Necessarium est concludere, circulari quodam motu, in circuitu agitari in animalibus sanguinem, et esse in perpetuo motu, et hanc esse actionem sive functionem cordis, quam pulsu peragit.*"—HARVEY, De Motu Cordis, cap. xiv.

ATMOSPHERIC PRESSURE.

Arguments drawn from Anatomy.

I had long remarked in every thing I heard or read on the circulation of the blood, that the pressure of the atmosphere was either entirely left out in the enumeration of its causes, or considered as merely a secondary agent. This appeared to me the more extraordinary, from the effects of pressure being so striking, when acting upon liquids moving in tubes. Harvey does not even allude to such a cause; and Haller, in speaking of the pulmonary circulation says, that* the pressure of the air may be passed over in silence. It seemed to me, however, impossible, that the alternate expansion and contraction of the thoracic cavities should not affect the contents of the

* Ut pressio aeris pro nulla potest haberi. (Haller, loco citato.)

great veins opening into them, in the same manner as the expansion of a pair of bellows would the contents of flexible tubes, in communication with their cavities; I reasoned thus:—

The right and left cavities of the thorax have within them each a lung or bag, divided into a greater or lesser number of distensible cells, communicating with one another, and with a common tube, the trachea. When the chest is enlarged by the act of *inspiration*, air rushes in through this tube, to distend the air-cells, and force them to occupy that space, in which the expanding parietes of the thorax tend to leave a vacuum. But as it is evident that the air would follow the expanding sides of the chest much more readily, if there were no cells to be distended, and as it is an unalterable law, that all liquids in communication with an enlarging cavity will be pressed towards it, if exposed at the same time to atmospheric influence; it became presumable that blood would be forced into the thorax through the cavæ during inspiration.

Having once caught this view of the part which respiration might probably bear in the circula-

tion, particularly of the venous blood, several known facts presented themselves in support of its correctness, *viz.*, the swelling of the external jugular veins during *expiration*, and their immediate collapse upon *inspiration*. The checking of certain hæmorrhages by forced inspirations; the fatal accidents that have been known to follow the opening or the dividing large veins, and above all, the situation of the heart itself, placed in the centre of the chest in a bag, at all times too large for its volume, and which seems not only protected from direct atmospheric pressure, but is probably enlarged in all its diameters by the act of inspiration.

Upon turning my attention more particularly to the anatomy of the thoracic viscera, I was struck with the analogy which I thought was observable between the mechanism of the heart, pericardium, and mediastinal pleuræ, as resembling a pair of bellows, and that of either lung within its proper cavity, compared to the same instrument.

The situation of the fibrous bag of the pericardium in the human subject, and the covering which its lateral surfaces receive from the medi-

astinal pleuræ, reflected over them from the roots of the lungs behind, and from the sternum and ribs before, are well known to all anatomists. When the lungs are expanded, their surface is necessarily enlarged. When the ribs carry forward the sternum, and when the diaphragm presses down the abdominal viscera, the internal surface of the thorax is *also* enlarged; consequently the pleuræ covering these surfaces is put upon the stretch, and that portion covering the pericardium on either side is pulled upon at its margins on both sides, in the directions best calculated, not only to protect the fibrous bag from pressure, but to enlarge its cavity throughout.

The motion of the sternum during inspiration, tends to bring the anterior surface of the pericardium forwards and upwards. The synchronous movement of the diaphragm tends to enlarge it downwards, and to complete the analogy. As each lung is furnished with a pipe, through which it receives and discharges air, so is the heart, with its receiving pipes (the veins), and its discharging pipes (the arteries), through which it receives and discharges blood.

But as the aorta, the great discharging pipe of

the heart, is equally employed during both stages of respiration in sending blood out of the thorax, it seemed probable (if my reasoning with regard to the effect of inspiration upon the blood of the cavæ were well founded,) that enough of blood should be brought into the chest during its expansion alone, to supply the discharging tubes during a whole act of respiration. Thus the necessity of a reservoir became evident, into which this blood might be drawn by the expansion of the three thoracic bellows. Having, by these arguments and others now unnecessary to be recapitulated, brought my hypotheses thus far, I came to the following presumptive conclusions.

1. That a liquid such as water in an open vessel, being by means of a tube placed in direct communication with the cavity of one of the great veins within the thorax of a living animal, would be forced by atmospheric pressure to rise in the tube, and that the motion of the liquid within the tube would be regulated by the respiratory movements of the animal.

2. That the same phenomena would be exhibited by establishing the same communication between

the liquid and any of the cavities around the vein.

The consideration of the pulmonary venous circulation I deferred altogether, until I should have ascertained by experiment, whether my theory with regard to the effect of atmospheric pressure upon the blood of the cavæ were likely to prove correct. I accordingly planned and executed the following experiment.

First Experiment.

Having first ascertained upon the dead horse, that a tube of proper size and length might be readily introduced down the jugular vein, as far as the anterior cava, I proceeded thus—

On the 16th October, 1824, I selected a horse condemned to be destroyed on account of an incurably diseased hoof, but sound in every other respect. The animal having been thrown upon his right side, I laid bare his left jugular vein, tied it below its middle, and about an inch below the ligature introduced into its cavity, in a direction towards the heart, a large-sized flexible catheter, having a spiral glass tube fitted into its

outer end*. The rounded point of the catheter was cut off above the lateral openings. The diameter of its bore was about $\frac{3}{16}$ of an inch, its length $10\frac{1}{4}$ inches. The diameter of the spiral tube at A. was $\frac{1}{8}$ of an inch, at C. it was something less. The length from B. to C. four inches.

When the horse was thrown, his breathing became almost entirely thoracic; the rising and falling of his ribs could be readily and distinctly counted. The respiration was also audible. The catheter having been pushed towards the heart as far as it would go, a ligature, which had been passed under the vein a little below the opening made to admit the catheter, was firmly knotted round both.

The point C. of the spiral tube, over which I had hitherto held my finger, was now immersed in a cup of water deeply coloured by a solution of common Prussian blue. The moment that I removed my finger, the blue liquid rose through the spiral, and flowed rapidly towards the heart. The sun happening at the moment to shine

* Plate, Fig. 1.

strongly on the tube, I saw, in the most satisfactory manner, the undissolved particles of blue pass up from the cup and round the spiral during *inspiration*, and halt or return slowly towards the cup during expiration. Not a drop of blood was seen to enter the tube, but bubbles of air sometimes appeared upon the surface of the liquid in the cup during expiration. The breathing being audible, allowed me to keep my eye steadily fixed upon the motion of the liquid, and to ascertain, beyond all possibility of deception, that this motion was entirely dependent upon the movements of respiration.

My very ingenious friend, Dr. Macann, to whose suggestions and assistance I am largely indebted, being stationed on the opposite side of the horse's neck, where he had not so good a view of the tube, by placing himself close to me, soon became fully convinced that the blue liquid moved upwards through the spiral in exact correspondence with the *inspirations*, and halted or returned towards the cup with the expirations.

To vary the proofs of this wonderful coincidence between the movements of the blue liquid

in the tube and the respiration of the animal, I withdrew the point C. from the liquid in the cup for a moment during *inspiration*, so as to admit one or two bubbles of air, and returned it again immediately. A space more or less extensive of the tube became thus transparent. Upon the next inspiration these bubbles were forced round the spiral with considerable velocity, and the whole tube again became uniformly blue by the ascent of more liquid from the cup. This part of the experiment, several times repeated, invariably afforded the same results.

A considerable quantity of cold water and also of air had now been forced into the vein and thence to the heart. The animal gave strong indications of suffering, and as the fact that inspiration produces a relative vacuum within or around the anterior cava was considered as fully established, the experiment was discontinued. I forgot to mention that towards the latter part of the experiment, when the animal's respiration became hurried and irregular, blood appeared in the tube on two or three occasions during *expiration*. The next inspiration, however, invariably restored the blue liquid to its place.

During the various trials and repetitions of this experiment which I made upon horses, I had occasion to remark, 1. That when the animal was standing, although the coloured liquid invariably rose in the tube, atmospheric pressure was never so distinctly marked as when he was prostrate. This I proved by experimenting upon the same animal in both positions.

2. That the connexion between the motions of the liquid in the tube and the respiration cannot be satisfactorily observed while the horse is standing, because his breathing when in the erect posture, and at rest, is scarcely, if at all, perceptible.

3. That when the respiration became hurried from whatever cause, or when it was embarrassed by disease, there was frequent regurgitation of blood through the tube, but never once did this occur except at the moment of expiration, and never under any circumstance did the liquid ascend in the tube, except at the moment of inspiration. This experiment, repeated upon the anterior and posterior cavæ of dogs, afforded similar results.

Here it is essential to remark, that if the com-

municating tube be introduced into the femoral vein of a dog or horse, and pushed no further towards the heart, inspiration will produce no effect upon the liquid in the cup, because the relative vacuum of the thorax can be filled up from the other veins of the animal's body, which will require a weight of atmospheric pressure to send forward their contents, *less* than would be necessary to force up the blue liquid, by the sum of all the secondary powers, such as contractility, *vis à tergo, &c.* The influence of the atmosphere invariably moves that first which requires the least pressure.

Considering the correctness of my first presumptive conclusion to be sufficiently established, I proceeded to put the second to the test, by the following experiment, calculated to ascertain the effect which a direct communication with the thoracic cavities around the cavæ would have upon a liquid, circumstanced as in the last experiment.

Second Experiment.

I introduced into the thorax of a dog near the median line and on each side of the posterior extremity of the sternum, a metallic tube, pointed like a writing-pen. The animal being placed upon his back the tubes were directed downwards and forwards parallel to the mediastinal pleuræ, which in the dog, in this position, suspend the pericardium from the sternum. To the external extremity of each tube was attached a small caoutchouc bag filled with a composition of lard and wax, and pierced at its bottom by a small hole.

As soon as the point of the tube had penetrated the pleura, I took a small flexible catheter, having at one end the barrel of a quill, in the side of which I had made a cut to act as a valve, opening readily from within outwards, and shutting in the contrary direction by its natural elasticity. The catheter thus armed, I passed into the hole in the caoutchouc bag, through the metal tube and into the chest. The little bag was attached to the margins of the wound by suture. This being done on both sides of the sternum, I next fitted

to the outer end of each catheter which had been hitherto plugged, a spiral glass-tube*, one end of which was already immersed in a coloured liquid. The communication being thus complete on both sides, the liquid rose rapidly through the spirals and flowed into the chest during inspiration, and remained stationary or fell during expiration. The movements of the liquid in the tubes were so regular, and so completely dependant upon the respiratory movements of the animal, that the one might be counted whilst observing the other. During inspiration I admitted into the glass-tube bubbles of air and small portions of the blue water alternately, so as to make the ascending column resemble a string of coloured beads, which played up and down through the spirals, particularly towards the latter part of the experiment, marking in a beautiful and striking manner the stages of the animal's respiration.

Two other metallic tubes, similar to those already described, were passed into the chest at two distant points, with the intention that the

* See Fig. 1.

openings of the catheters should be placed between the pleura costalis and the lung on either side; but having operated too near the diaphragm, one of the catheters passed between it and the stomach and liver, the other between it and the posterior surface of the lung. No motion whatever was observed in the liquid communicating with the abdomen, whilst that of the liquid communicating with the anterior surface of the diaphragm was precisely similar to the movements noticed in the other tubes.

Before the dog was destroyed, a stop-cock was fitted into his trachea, so as to command his respiration. When the stop-cock was shut, and the animal made powerful efforts to inspire, the blue liquid flowed upwards through the spirals with much greater force and rapidity than when the passage of the air through the windpipe was unobstructed. The ends of the two catheters that had been first introduced were found, when the body was opened, one on each side of the pericardium, between it and the concave surface of the lung, which had not suffered the slightest injury.

Third Experiment.

A similar communication still remained to be established with the bag of the pericardium, but hitherto in all the trials which I had made upon the dog the cavities of the heart had been penetrated, and the results of the experiments thus rendered inexact. The long and delicate connexion between the pericardium and sternum in this animal, added much to the other difficulties. The pericardium of the horse I found to be the most favourably circumstanced for my experiments. In this animal it is attached to the periosteum of the upper surface of the sternum from the fourth rib backwards, extending its adhesion posteriorly to the base of the xyphoid cartilage, from whence it turns sharply upwards and forwards behind the heart to be attached to the lower surface of the posterior pulmonary veins. By dissecting up the point of the xyphoid I was able to pass a pointed tube along its upper surface, through the lower margin of the diaphragm, and into the pericardium at its posterior and in-

ferior angle, without penetrating the peritoneum. The tube was armed with a caoutchouc bag as in the last experiment. Through this bag I passed a flexible catheter into the tube nearly to its point. Thus when the pericardium was penetrated, the catheter could be pushed in immediately, and to any length, so as to prevent the heart from being wounded by beating against the point of the tube.

In all the cases in which I succeeded in establishing a communication between the bag of the pericardium exclusively and a coloured liquid, the fluid rose in the tube as rapidly as in the former experiments, and, in all but one, its motion upwards was governed by the animal's inspirations. In all, however, with the exception of this single case, although the liquid invariably halted or descended during expiration, there was an oscillation of the fluid upwards, which seemed independent of respiration, but could not be observed during inspiration, because then it was confounded with the general motion of the liquid upwards. This third movement was acknowledged by my friend Mr. Bennett, an anato-

mist and physiologist, as distinguished as he is modest.

In the case of exception, the horse was in the last stage of exhaustion. The pulsation of none of his arteries could be felt, and the liquid continued to flow upwards from the beginning to the end of the experiment, without any intermission, and this whether he was placed upon his back or his side.

When either of the ventricles was penetrated—an accident which frequently happened, as long as the blood was allowed to flow through the tube—the animal did not seem likely to perish sooner than he would have done by any other hæmorrhage of the same amount; but when the effusion took place within the pericardium, he invariably died when the bag was filled to its utmost extent. In these cases the heart was found compressed, and smaller than natural, in the midst of an immense coagulum.

Professor Coleman was kind enough to afford me an opportunity of repeating the first and third experiments at the Veterinary College on Friday, the 10th February, 1826. There were present,

besides the Professor and his numerous and respectable class, Mr. Sewel, Dr. Bostock, Mr. Wardrop, Mr. Broughton, Dr. Macann, and many other highly distinguished men.

The subject was a donkey. All expressed their satisfaction at the entire success of the experiments, but particularly that upon the pericardium. The tube was introduced into the cavity of this bag without inflicting the slightest injury upon the heart. The liquid was taken up with wonderful rapidity, and in perfect accordance with the dilatation of the thoracic cavities during inspiration.

Upon opening the animal, the flexible tube was seen projecting some inches into the bag of the pericardium, in the depending portion of which was found a considerable quantity of the liquid used in the experiment.

PULMONARY VENOUS CIRCULATION.

Before I state the inferences which appear to me deducible from the facts already recorded, I shall say a few words on the motion of the blood in the veins of the lungs.

Since it is evident that the blood sent into the aorta cannot arrive through any other channel than the pulmonary veins, it will not be unreasonable to conclude, either that the lungs must be equally pervious to the blood of the right heart during all the stages of respiration, or, that if they are not so, there must be a reservoir from which the left heart can be supplied during the period when they are least pervious.

The lungs themselves are placed within two cavities, which, as we have just seen, are in a state of tendency towards the formation of a vacuum during the act of inspiration, and therefore the pulmonary veins would, at first sight, appear to be all equally exempt from pressure in every part of the thorax, at the moment of its expansion. A more attentive examination, however, will shew, that nature has ensured, by a beautiful and simple mechanism, as constant and as ample a supply to the left heart, as she has to the right, and by the same means; *viz.*, atmospheric pressure. I shall take the thorax of the horse as an example to illustrate the pulmonary venous circulation in the warm-blooded mammalia.

In the horse, the posterior cava quits the spine as soon as it arrives at the crus of the diaphragm; it then runs along this muscle for a considerable distance, until it arrives opposite the base of the heart, when it passes into the thorax like a rope across a room, unconnected with every thing for five or six inches of its length, except with the thin, gauze-like membrane which extends from the right side of the pericardium to the diaphragm, and which seems to hang from the outer and upper side of the thoracic cava like a curtain. As this membrane conducts the phrenic nerve to its destination, I shall take the liberty of calling it the phrenic curtain, not being aware of any other name by which it may be distinguished.

The two great posterior, or right and left pulmonary veins form, by their early confluence in the right cavity of the thorax, behind the pericardium, a capacious reservoir, which is still further enlarged by the junction to its left side more anteriorly of the two common trunks of the principal middle left pulmonary veins.

There is a deep notch lined by pleura made into the inner face of the great right lung from

before backwards, almost to its root. The irregularly pyramidal slice of lung thus half-detached from, but still adhering by its base to the parent-lobe, is the middle lung of quadrupeds. It is thrust upwards and to the left of the loose posterior cava, but without forming the slightest adhesion to this vessel. In this situation, then, it would hang across the vein, were not a portion of its upper, or rather left, surface pasted up to the floor of the great reservoir just mentioned, and to some inches of the bevelled edge of the left lung, each preserving its proper pleura. The point of this little lung, with all its lower sides and angles, are free. This connexion between the middle lung and the roots of the posterior pulmonary veins is not the only one. Two, three, or more veins coming from the left superior anterior angle of the middle lung open their trumpet-shaped-mouths into the floor of the reservoir precisely at the three points best calculated to pull it downwards and to the right, when the middle lobe, filled by inspiration, is strained towards its parent lung by the pleura lining the notch. The anterior, the largest of these connecting veins,

is inserted into the centre of the common trunk of the two middle veins already mentioned. The second, into the centre of the conflux of this trunk, with the great left posterior vein. The third, (in the lung now before me) to the left of the centre of the conflux of this last with the right posterior vein. Thus, if the middle lung were pulled down from its adhesions to the left of the cava, and at the same time revolved upon its base towards its parent lobe, its veins prolonged would form arcs of that angle, of which the right phrenic curtain and the floor of the reservoir would represent the sides. When the horse's lungs are artificially inflated, the middle lobe makes precisely the movement described.

In this arrangement there are the following remarkable circumstances: 1st. The principal veins of the left lung enter the right thorax. 2d. The veins of the middle lung cross the largest vein of the right lobe, to empty themselves into a particular point of the conflux of the left pulmonary veins. 3d. The veins of the middle lung empty themselves at one of its extremities, instead of at

its root. The purpose of this mechanism I illustrated in the following manner:—

Fourth Experiment.

After having laid bare about half an inch of the lower surface of the left posterior pulmonary vein, I introduced into its cavity, towards the heart, the end A of the tube (fig. 1.), tying the vessel round it. The point C was immersed in a glass of red wine and water. By pulling gently upon the apex of the middle lung, in the direction in which it would move when inflated, the coloured liquid rose with such force, that it flowed abundantly into the reservoir. When I ceased to pull, the liquid ceased to flow. When I pulled the lung horizontally towards the left, the coloured water seemed rather inclined to return towards the glass. When I pulled horizontally towards the right, the liquid rose, but the more the middle lung was lifted from its attachments, the more rapidly the liquid flowed.

The right posterior pulmonary vein, and right side of the great reservoir, have no vein entering

them from the middle lung, because the root of the posterior cava is extensively attached to them a little farther forward.

The diaphragm in its retrograde descent pulls upon the posterior cava in a direction downwards and backwards. The lower floor of the left, and the upper of the right sinus venosi, are thus removed from the axes of their respective cavities. The phrenic curtain pushed to the right, by the expansion of the middle lung, favours this movement of the cava, while it tends to widen its tube.

The cavities to which this distending mechanism is applied during inspiration are exempt from pressure, whilst the pulmonary veins in direct communication with them are exposed to the full pressure of the air rushing in by the trachea to distend the air cells. Besides, the pressure of the atmosphere is exerted upon an extent of surface of the pulmonary veins, holding an inverse ratio of proportion to the capacity of their tubes.

To comprehend the mechanism by which the great pulmonary veins or reservoirs of the left

heart are expanded in man, it is only necessary to observe their connexion with the pericardium. A little tongue appears to be cut in this bag from behind forwards, to allow each vein to pass on to the heart through a kind of square hole. This tongue is then pulled backwards and outwards a little out of the general line of the insertion of the pericardium, and firmly glued to the anterior surface only of the vein. This mechanism is distinctly seen in man, as well on the right side as on the left, within the pericardium. There is a little pouch over each pulmonary vein, having its point directed outwards, whilst in quadrupeds no such contrivance exists. When the pericardium, therefore, in man is brought forward by the elevation of the sternum, and when it is enlarged at its base by the expansion of the lungs, the anterior surfaces of the pulmonary veins, where they enter the left sinus venosus, must be strained forwards, whilst their posterior surfaces are retained in their place.

If any further illustration were necessary of the use of this peculiar attachment of the pericardium to the pulmonary veins in man, we have

only to observe, that if the loose bag be pulled, however forcibly, in the direction which the movements of respiration give it, the strain will be brought on the anterior surfaces of the veins only, never on any portion of the arteries.

This peculiar mode of connexion between the pericardium and pulmonary veins does not exist in quadrupeds, except as far as concerns the anterior veins of the left lung, and even in these in a less remarkable manner; whilst the accretion of the contiguous sides of the cavas and pulmonary veins, so marked and so extensive in quadrupeds, is not found in man, at least not on the outside of the pericardium. In support of the importance of the pericardium in the mechanism of the circulation, it may be remarked, that it is perhaps the only part of the animal which is never found entirely wanting.

I shall detail one more experiment, because it affords additional evidence of the effects of atmospheric pressure upon the blood of the veins, which in this case performed the part allotted to the blue liquid in the other experiments.

Fifth Experiment.

On the 30th November, 1824, I took a horse, which had undergone no previous experiment whatever, threw him, secured him, and laid bare his left jugular vein for about eight or ten inches, following the vessel as far towards the chest as I thought safe. I next passed a ligature under it at either extremity of the external incision: these I knotted lightly, each over a small cork. Considerably nearer the chest than the middle of the incision, I made an opening into the vein, and introduced into its canal, towards the heart, the end A of the glass instrument (fig. 2) as far as the globe would permit. The vessel was secured round the tube by two turns of small twine, lightly knotted, above the reverted lip of the lower opening. I next divided the vein behind the globe, and passed the upper end of it over the opening B, securing it as before. This being done, I cut upon the corks, first the lower, then the upper, ligature. The blood now rushed rapidly through the globe. Its motion was at first visible, but,

after a few seconds, could not be perceived from where I sat, the horse lying prostrate under me. The apparatus was well adjusted, and kept its place. The blood, I knew, passed freely into the chest, for there was no enlargement of the vein above the globe.

I now carefully washed the outside of the glass, and placed myself upon my knees, supporting my right hand extended upon the ribs of the prostrate animal. By this arrangement I was able to apply my eyes close to the globe, and at the same time to feel, in the most exact manner, the expansion and collapse of the thorax. The dark blood, which nearly filled the globe, left a small space unoccupied at its upper side. Very little light, however, was reflected from the mass below, and therefore, whilst I observed it in a sitting posture, there appeared to be no motion on the inside. When I applied my eyes closely, I could distinctly perceive the blood rise within the globe, and, as it approached the upper part, assume a lighter red, as if a froth were raised upon it by the rush to pass the lower opening. This appearance regularly accompanied the elevation of the ribs,

over which I held my right hand expanded. Having once caught the proper light, I could perceive distinctly the motion of the blood in the globe, keeping exact time with the inspirations. The horse lay quietly, and breathed tranquilly. The tube kept its place in the most satisfactory manner. There was therefore neither hurry nor confusion. I observed at leisure the perfect coincidence of the passage of the blood through the globe with the inspirations of the horse. This I could not have done so well in any other attitude, as the breathing was not sonorous in this case; for I could not have fixed my eyes on the glass and on the thorax at the same time.

I have said that I observed the blood flowing through the bulb of the tube in exact correspondence with the expansion of the chest. The synchronism was just as well marked as in the experiments with the blue liquid and the spiral, with this exception, however, that in the present case there was no regurgitation, because the breathing was not hurried. My observations were prolonged, repeated, and careful. After watching the globe for some minutes, I resumed my sitting-

posture, returned again to the kneeling position, and observed the same phenomena going on without the slightest alteration.

Three or four times I repeated this proceeding in different lights, and constantly found the same uninterrupted coincidence between the passage of the blood through the globe and the elevation of the ribs.

This experiment appeared to me so conclusive and unequivocal, that I shall never require a repetition of it for my own satisfaction.

I had often tried this experiment before, but without having obtained very satisfactory results. My failure I can now with confidence attribute to the length of the tubes which I had hitherto used, sometimes reaching from the angle of the jaw to the root of the neck. In these cases, as soon as the globe was filled, all movement ceased, owing to the blood being protected from atmospheric pressure through so long a portion of its horizontal course, which also deprived it of the influence of gravitation. My complete success with the short tube justifies this remark.

CONCLUSIONS.

From what has been said, and from what has been observed in the experiments, the two following facts may be considered as proved:—

First,—That the cavities of the great veins within the thorax, and all the thoracic cavities, draw towards them the fluids with which they are placed in direct communication.

Second,—That this attraction, or suction, never takes place but during the expansion of the thorax, that is, during *inspiration.*

From these facts, and from what we have seen in the last experiment, we may conclude,—

1st. That the blood which *runs contrary to its own gravity, arrives at the heart only during inspiration.*

2dly. That the power which impels it at this moment through the veins, is atmospheric pressure.

3dly. That as this power can be applied to the blood of the veins only at the moment of inspiration, this blood must move with a velocity which

is, to that of the blood moving through the arteries, as the time occupied by a whole respiration is to the time occupied by a single inspiration.

4thly. As the blood passes through the greater veins during inspiration only, whilst it is incessantly traversing the arteries, it follows, that an accumulation must take place somewhere between these two orders of vessels, and that the quantity of this accumulation must be to the quantity which passes through the arteries during an entire act of respiration, as the time of one expiration is to that of a whole respiration.

5thly. That, as it makes no difference with regard to the event, whether the accumulation which must be prepared for the expansion of the thorax, be made by two pulsations of the arteries or by ten, it follows that the frequency of the pulse cannot be taken as the measure of the velocity of the blood returning to the heart, because it is the repetition of the inspirations which must regulate this velocity.

6thly. That there are three quantities of blood; one passing through the arteries, one which is

sucked up by each expansion of the thorax, and a third, which is collected during expiration between these two points. When therefore the respiration becomes hurried, this third quantity is diminished, whilst the other two are increased in proportion; but as the heart can admit only a certain quantity, the expanding cavities regurgitate the surplus during their collapse. Hence pathological phenomena, into which I shall not enter for the present.

7thly. That the lymph and chyle must be sucked up towards the chest, through the direct communications which the vessels peculiar to these fluids have with the subclavion and other veins. The question of absorption, therefore, which has hitherto puzzled physiologists so much, may now be considered as decided, for it is clear that the open mouth of a vein, or of any other vessel, having the same kind of communication with the thoracic pumps, must absorb in direct proportion to the sucking power applied to it, and to the pressure exercised upon the matter to be absorbed *.

* See Experiment, No. 1, page 10.

If this last proposition be well founded, so ought to be the following corollary, *viz.:*

That the application of a powerful cupping-glass to a recently-poisoned wound, would prevent the absorption of the poisonous matter.

8thly. It being now evident, from every thing that has been said, that the blood in the veins is placed under the influence of atmospheric pressure, it would be curious to trace the connexion which appears to exist between disease generally, intermittent fever for example, and the daily barometric variations.

9thly. The preceding facts explain also why animal life cannot be maintained beyond a certain degree of atmospheric rarefaction, and why it must cease as soon as the pressure of the surrounding air ceases to be superior to the gravity of the column of blood. Birds are provided with a respiratory mechanism, which, in some measure, exempts them from this inconvenience.

10thly. At the cardiac extremities of the great veins there exists, as we have shewn, a mechanism, which, when called into action by the expansion of the thorax, distends their cavities,

and, consequently, causes the suction of the blood of the veins of the lesser, as well as of the greater, circulation. Now, as this mechanism can act only during inspiration, and as, from its construction, and its position, it must necessarily affect those portions of the auricles within the pericardium, called the sinus venosi, it follows that there can be no alternation of contraction between these parts of the auricles and the ventricles corresponding to the pulse, because the sinus venosi must be in a state of progressive distension from the beginning to the end of *inspiration.*

The influence which this disposition of the parts, as well as the series of facts hitherto noticed, may have upon the motion of the heart, and upon the passage of the blood through this organ, will form the subject of another Memoir.

I shall not now trespass longer on the attention of the Academy, by endeavouring to enumerate all the conclusions deducible from the facts, which, I trust, will be considered as proved by the experiments. In whatever light the results of my researches may be regarded, whether

as merely explanatory of some doubtful points, or as sufficiently novel and important to constitute a discovery, I have brought them as an offering to the Temple of French Science, where, fortunately, Prejudice has not yet stript Physiology of that portion of philosophic honour which is her due.

Paris, June 6, 1825.

SUPPLEMENT.

To illustrate the physical application of the principles hitherto advanced, to the circulation of the blood through the veins, and to shew that the two paramount laws of nature, gravitation and atmospheric pressure, are equally influential with regard to animated as to inert matter, we shall suppose two tubes of equal diameter, each in the form of the letter U *. Let each of the branches of these tubes be fifteen inches in length; one of these tubes shall be formed of a hard substance, such as glass, the other of a yielding distensible material, such as a vein.

(1.) Let mercury be injected into the branch A of the first or hard tube, it will mount in the branch B, until both are full; and if the injection be continued, the mercury will flow out at B in

* See plate, fig. 3.

jets equal to and synchronous with the injections at A.

(2.) If the same operation be performed on the second or flexible tube, the same quantity of mercury will not be sufficient to fill it, because the lower parts of the tube will be distended by the pressure of thirty inches of mercury, that is, of fifteen inches on either side. None, therefore, will flow out at B, until a much greater quantity than that employed in the first operation shall have been injected at A. Even after the mercury shall have been raised to B in the flexible tube, it will not flow out in jets either equal to or synchronous with those injected at A, because a part of the injecting force and of the mercury injected, will be employed in producing fresh distension. The slightest alteration, therefore, in the distensibility of the tube will be felt at B, whatever be the amount of the injecting power at A.

(3.) Let the branch B of the inflexible tube be prolonged to thirty inches, and let a vacuum be established in the reservoir E, with which this branch communicates: the mercury in the branches A and B will be forced by atmo-

spheric pressure up to E. If the mercury can be removed from E according as it arrives, without destroying the vacuum, all that is injected at A will flow into the reservoir E.

(4.) Let us suppose the second or compressible tube, under the circumstances just described, the portion B E being empty, its walls will be pressed flat by the weight of the atmosphere, because the resistance which they offer is much less than that of the gravitation of the mercury, which, in this case, will not rise towards E, unless the tube be rendered incompressible by the introduction of another tube capable of resisting the pressure of the air, as in the first experiment.

(5.) If at the moment that the vacuum is formed, the flexible tube be full as far as E, of a liquid ten or twelve times lighter than mercury, and if it be divided at short distances by valves, each forming a base to the column above it, and if the injections be continued not only at A, but at many other points between C and E, and lastly, if the sides of the flexible tube be attached to the parts about it whose natural position tends to keep these sides asunder, then the tube B E will

not be pressed flat, and the vacuum at E will act upon the contents of the whole tube, as soon as the injecting power shall have placed them within the sphere of its attraction.

(6.) Thus it is evident, that in the case of the inflexible tube the injecting power alone applied at A will discharge at B the precise quantity injected, and that atmospheric pressure alone will force the mercury to rise from C to the vacuum E, without the assistance of the injecting force.

(7.) In the case of the compressible tube, the injecting power alone, however great we may suppose it at A, can never produce a flow of liquid from B precisely equal to the quantity injected, whatever qualities we may endow the tube with, provided that it retain its *distensibility*. (2.)

(8.) If the mechanism by which the mercury is removed from the reservoir E, be made to inject it into A, then as long as the vacuum can be maintained, and the tube remains entire, the circulation of the mercury will continue, provided, with regard to the incompressible tube, that the quantity of liquid remain unaltered; whereas, this

condition is not at all indispensable to the persistence of the circulation through the compressible tube, because its own distensibility on one hand, and the pressure of the air on the other, will always accommodate its capacity to the volume of its contents.

(9.) If the extent of the vacuum be diminished, the quantity of liquid being the same, there will be accumulation in the lower parts of the flexible tube.

(10.) If the liquid in the branch C E of the flexible tube, be forced by mechanical pressure towards the part which offers least resistance, viz., the vacuum, then the reservoir will be compelled to dilate itself more rapidly, the instrument which empties it must increase its action, and produce increased velocity in the contents of the branch A C.

(11.) If the distension of the reservoir E brings up more liquid than is emptied into A, then its contraction will force a part of its contents to regurgitate towards B.

(12.) If the injection of the liquid into A should cease altogether, or become very trifling, then

the continuity of the column will be lost in the branch B by the weight of the atmosphere pressing its sides together, and the expansion of the reservoir must be diminished or cease altogether. In this case, incline the tube towards E, the gravity of the liquid will favour the expansion of the reservoir, which will be renewed without any difficulty, because it is no longer opposed by the gravitation of the liquid.

(13.) If an opening be made at D in the branch C E of the inflexible tube, air or any other fluid will enter by this opening, will force the mercury up to E, and occupy its place; but in the flexible tube, the weight of the atmosphere will press the walls of the tube together above the opening, and the vacuum will cease to act upon the portion below it. In this case a part of the liquid injected at A will flow out at D, and the rest will be employed in distending the lower portion of the tube.

(14.) If a vacuum be applied over the opening D—first, neither air, nor any other fluid can be forced into the opening; secondly, a portion of the liquid which otherwise would have been com-

pelled to rise to E, will be recalled towards D, and *à fortiori*, a much larger portion of the liquid contained in A C.

(15.) It is now evident, that the liquid contained in the flexible tube can mount to E only, at the moment when the reservoir is expanding, and that at the instant when the tendency to a vacuum ceases in the reservoir, the liquid will obey the law of gravitation, and will distend the lower parts of the tube. (2.)

(16.) It is also easy to conceive that the motion of the liquid in the branch A will be in direct proportion to the injecting power, as the velocity of the contents of the branch B will be to the expansion of the reservoir E, and that a mutual influence will be felt in both branches through their communication at C, whether by one or more canals.

(17.) Let the reservoir E be *now* the most dependent part of the tube. The gravitation of the liquid will be opposed to the injecting power in the branch A, whilst it will favour the influence of the vacuum in the branch B. But as atmospheric pressure is everywhere equal, if the contracting

force of the reservoir E be able to resist the gravitation of the liquid in B, then that which is injected at A can be received into E, only at the moment that the tendency to a vacuum takes place.

(18.) If the tube be supposed incompressible from A to B *only*, then the liquid will fall from B in jets equal to and synchronous with those injected at A, and its gravitation towards the reservoir will only operate from B to E, where it will accumulate, producing distension proportioned to its quantity, and to the interval between the expansions of the reservoir. The dilatation of the reservoir will affect the contents of the tube B only as far as it is compressible.

(19.) If a portion of the tube A B be rendered compressible at C, (E being still the most dependent point,) a *depression* and *elevation* will be perceptible at C, corresponding to the *expansion* and *contraction* of the reservoir E. If this compressible portion be again rendered *incompressible*, the depression and elevation must cease at C, because atmospheric pressure can no longer affect it.

(20.) Let us suppose that the portion C be again rendered flexible, and that it is the lowest point of the tube. In this case the force of gravitation in both branches, and the injecting force in the branch A, will direct the liquid towards C, and the *depression* and *elevation* will not be perceptible, but the portion C will be permanently distended. (2.)

(21.) Let us now apply these data to the living animal, to man, for example. The aorta and lower cava represent the flexible tube. The thoracic cavities, but particularly the pericardium, are the reservoirs in which the tendency to a vacuum takes place during *inspiration*. The heart is the instrument by which the contents of the reservoir are injected into the branch A, without destroying the vacuum. It is not difficult to perceive that every thing we have said relative to the flexible tube is perfectly applicable to the parts below the heart.

(22.) The application of the data resulting from the case in which the tube is supposed to be *partly incompressible*, and where the reservoir is

the most depending point, merits more particular attention.

(23.) This tube is represented in man by the carotid arteries on one side, and the jugular veins and upper cava on the other; the incompressible portion of the tube by the cranium. As the form of the adult head is incapable of alteration, so must the volume of its contents remain unaltered, however they may be modified in point of density. The veins which run between the two tables of the flat bones of the skull, and in the substance of the vertebræ and other bones, present striking examples of the inflexible tube *.

(24.) The pulsation observed in the jugular veins, synchronous with that of the arteries, proves that the blood which runs in the veins of the cranium is subject to the general laws of gravitation. The same experiments performed upon the jugular veins of animals in the horizontal and vertical positions afford different results.

* M. Brechet was kind enough to give me an opportunity of examining his splendid preparations and plates of these veins.

Sixth Experiment.

I fixed the glass tube (fig. 2), in the jugular vein of a horse while he was standing, in such a way that the current of the blood must pass through the globe, and I observed, 1st, that the jets which fell from the end next the head were not synchronous with inspiration; 2dly, that they were more frequent than the pulse, but that the beat of the artery had a marked influence over them. Thus the jets falling into the globe became much less distinct when the carotid was even lightly pressed, than when it was free; but the influence of gravitation was constantly sending some drops into the globe. When the horse was thrown, and placed horizontally, the movements of the blood through the globe were perfectly synchronous with those of inspiration. When the horse was again placed on his legs, the vein above the upper end of the tube having become straightened by exposure to the air, a pulsation was observed at that point, the acme of whose swell was precisely synchronous with that of the carotid. (18.)

This experiment accounts for the difference hitherto observable in the opinions of physiologists, as to the cause of the pulsation of the jugular veins; some having made their observations upon man in the vertical position, others upon animals placed horizontally.

There is at this moment, in one of Professor Laennec's clinical wards, a patient, aged sixty-eight, in whose external jugular veins, and upper portion of the superficial thoracic veins, a regular pulsation has been observed for a considerable time. It has sometimes extended to the veins of the upper arm. The jugulars begin to swell before the artery, which beats forty-eight in the minute, but they arrive at their acme at the moment that the artery strikes the finger. The bleedings ordered for his disease, (hypertrophia cordis,) and a diarrhœa, which sometimes occurs, diminish the venous pulsation, but have never removed it. When this man is made to recite any thing, the pulsation ceases entirely, but the veins continue to increase in size. (18.) When he inspires, in order to continue the recitation, the veins collapse immediately, and so on as long as he con-

tinues to speak. When the head of this patient is placed lower than his thorax, the veins of the neck swell prodigiously, and their pulsation ceases. (17.)

This man lately became dropsical, his abdomen rapidly increased in volume, with oppressed respiration. The pulsation of the jugulars however, still continued. He was tapped some days ago, and from twenty-five to thirty pints of hydropic water were drawn off. At the morning visit, after this operation, there was no pulsation observable in the veins of the neck or chest. The jugulars remained perfectly collapsed, and became prominent only when he coughed or expired strongly. (17—18.)

The accumulation of blood which, before the tapping, used to extend in the jugulars almost to the angle of the jaw, now takes place below the clavicle, and the jets which fall from the head, pass through these veins without being perceived.

Professor Laennec, besides permitting me to note these observations in his hospital, condescended to verify their exactness with me at the

bedside of the patient*. To this learned physician, all foreigners, attending his practice and his most interesting pathological lectures, are largely indebted, for the kind assiduity with which he directs their research.

(25.) With regard to the elevation and depression of the brain and its membranes, which, under certain circumstances, are observed to take place in living animals, I shall take the liberty of quoting the words of Haller.

"Ergo si vivo animali non nimis debilitato, cranium aperueris, aut trepano aut unco, duramque matrem detexeris, et digito à cranio depresseris, videbis ad singulas inspirationes subsidere cerebrum, aut solum aut cum suis involucris; vicissim idem cerebrum surgere, cranio se admovere, digitum impositum repellere. Et vix respirationis in cerebrum effectus demonstrari potest, nisi duram matrem à cranio depresseris†."

* I hazarded an opinion that the jugular pulsation would return again with the return of the dropsical effusion and consequent swelling of the abdomen. This prognostic was fully verified by the event.

† Tom. ii. lib. 4.

The causes of these phænomena, according to Haller, are, first, The greater facility afforded by the expansion of the lungs during inspiration, to the passage of the blood through these organs. "Nascitur ergo derivatio, et sanguis venosus undique ad eam sedem confluit." Secondly, The obstacles opposed to this same blood during expiration. "In expiratione thorax contrahitur, comprimuntur pulmones, auriculæ, venæ cavæ, fit refluxus in venas cerebri. Hinc presso, ut ego presseram thorace, elisâque venâ cavâ, perinde cerebrum elevatur *."

Here it is important to remark, that even after

* Since the printing of my Memoir sur les Causes du Mouvement du Sang dans les Veines, the following passage has been pointed out to me in the Philosophical Transactions of 1810, (Part I.) as in a great measure anticipating my views, with regard to the influence of the expansion of the thorax upon the return of the blood through the veins.

"At the instant that the chest is dilated for the reception of air, its vessels become also more open for the reception of blood, so that the return of the blood from the head is more free than at any other period of complete respiration. On the contrary, by the act of expelling air from the lungs, the ingress of the blood is so far obtructed, that when the surface of the brain is exposed by a trepan, a successive turgescence and subsidence of the brain is seen in alternate motion with

a portion of the dura mater has been laid bare, the *elevation* and *depression* of the brain do not take place, so long as the membrane, by its adherence to the margins of the opening in the bone is able to resist atmospheric pressure; but as soon as a part of the tube becomes compressible, by the separation of the dura mater from the cranium, these phænomena become apparent, unless the head of the animal be placed in the most depending position. In this case, they cannot take place, for the reasons already stated. (20.) This fact I have proved by direct experiment upon the living animal.

(26.) From what we have seen in the Memoir, and from what has been said in the Supplement,

the different states of the chest."—*Croonian Lecture, by* W. H. Wollaston, M.D.)

The illustrious author, for whose transcendent talents I have ever entertained the most profound veneration, will not, I trust, be offended at my observing, that though he has not quoted the name of Haller, the whole passage is a close translation of the extracts from that great physiologist, which I had placed in my text, without having seen the very interesting and ingenious lecture just quoted. This passage, therefore, cannot be supposed to have advanced our knowledge of the causes of the progression of the blood in the veins one point beyond where Haller left it.

it is evident that fluids, whether moving through living, or through inert tubes, obey the laws of pressure and of gravitation; and that in the quiescent living animal, the only demonstrable active powers employed by nature to propel the contents of the veins towards the heart, are—

First, The impulse given by the pressure of the heart itself, continued through, and propagated by the arteries. By this power the blood is sent into the situation where it can be most favourably acted upon, by

Secondly, Atmospheric pressure, diminished or entirely taken off around the cardiac ends of the venous tubes during the expansion of the chest, but unaltered and entire around every other part of their surface, opposed only by the gravity of the fluid acted upon.

Thirdly, Gravitation, when the heart is relatively the most depending point, or when this power is acting with the pressure of the heart's contraction upon the base of the venous column.

Of these powers the pressure of the atmosphere is by far, the most intense in its degree, the most constant in its influence, and the most

unvarying in its amount. It is that without which the circulation could not be maintained beyond a few moments.

Hence it must now be needless to repeat that the constant supply of blood to the heart cannot depend solely upon the causes to which it has been hitherto ascribed, as already stated at the commencement of the memoir.

(27.) The following phænomena, amongst others connected with the venous circulation in man, afford still further proofs of the identity of the laws which preside over the motion of fluids, whether through organized or in lifeless tubes.

1. The swelling of the lower extremities in habitual dyspnœa. (9.)

2. The effect of violent bodily exercise. (10.)

3. Pulsation of the veins synchronous with respiration. (11.)

4. Fainting from loss of blood, and the best mode of relieving it, by placing the head and heart lower than the rest of the body. (12.)

5. The effect of opening a vein at a distance from the heart. (13.)

6. The effect of a vacuum established over this opening. (14.)

7. The circulation within the cranium, between its tables, and in the substance of other bones. (18.)

8. The swelling of the jugulars during expiration. (18.)

9. The pulsation of the jugulars corresponding to that of the arteries. (18.)

10. The elevation and depression of the brain and its membranes in infants, before the closing of the fontanelles, and in adult animals when a portion of the cranium is removed.

(Signed) DAVID BARRY.

INSTITUTE OF FRANCE.

Royal Academy of Sciences,
Paris, August 30, 1825.

The perpetual Secretary of the Academy for the Natural Sciences certifies, that the following is extracted from the Notes of the Proceedings of the Sitting of Monday, the 29th of August, 1825.

REPORT UPON DR. BARRY'S MEMOIR, ON THE MOTION OF THE BLOOD IN THE VEINS.

The circulation in the vertebrated animals is one of the parts of physiology upon which we have acquired the most positive degree of knowledge. Our more exact notions however, do not date farther back than the beginning of the sixteenth century, the epoch when Harvey demonstrated the true mechanism which gives motion to the blood, and which favours its continual transport through the system.

Every one knows that the tubes which go out from the heart, and through which the blood is propelled, and directed to all the parts of the

body, are called arteries; and that the tubes which conduct the blood, the chyle, and the lymph, to the heart, have received the name of veins. In short, that the heart itself, the organ which, to a certain degree, determines the mode of the circulation, varies as to its position, its structure, and many other appreciable circumstances, whilst its essential mechanism, by which its functions are executed, remains nearly the same.

The direction in which the venous blood is constantly carried towards the heart was noticed by Michael Servet, more than fifty years before Harvey made those direct experiments by which he ascertained the true mechanism of the circulation. Notwithstanding this important and memorable discovery, many discussions have since arisen as to the true causes of the *progression of the blood in the veins.* It is of importance to the question which we are about to examine, to give a brief account of the leading opinions which have been started upon this subject, without, however, entering into a chronological history of them.

We shall place at the head, the impellant action of the heart and arteries, which was supposed to be continued through the venous capillaries by the pressure exercised upon them at their anastomoses with the arteries. This was the opinion of Harvey. According to Bichât, the absorbing power of the venous capillary system is sufficient to originate, and afterwards to keep up the progression of the blood through the veins, assisted by the action of the coats of these vessels themselves. In fine, according to the opinions of various authors, a great number of secondary causes facilitate this action of the veins; such as the motion of the great arterial trunks, generally placed between two veins; the pressure exercised both externally and internally on all the organs by the skin, by the muscles, by the viscera, which collapse, and are distended alternately. But the action of respiration was more particularly noticed, from its evident connexion with the mechanical return of the blood by the veins. To explain this phænomenon, some supposed that the blood was brought up with greater or less velocity, according as the lungs

were more or less empty (RUDIGER). Or as a deeper and more rapid inspiration allowed a freer course to the blood in the lungs (SANTORINI). HALLER, tom. ii., of his Physiology, page 333, quotes a great number of experiments, which he repeated upon living animals. In those of Valsalva and Morgagni he observed, when he laid bare the great veins, such as the anterior and posterior cavæ, the jugulars, the subclavians, that it was at the instant when the animal made a deep inspiration, that the venous blood arrived at the heart; that it was at this moment that all the veins unloaded themselves, grew pale, collapsed, and emptied themselves of the blood which they contained; and that during the expiration which immediately followed, the same veins swelled, became livid, round; and that the more distinctly the two periods of respiration were marked, the more apparent these phænomena became.

Morgagni had already stated (*De causis et sedibus morborum, lib.* 19, art. 33 et 34), that, by attentively observing the jugular vein of a living dog, whilst he held his hand upon the abdomen

of the animal, he had clearly ascertained, that at each time the belly was elevated by the act of inspiration, at that very moment the vein collapsed, to swell again as soon as the parietes of the abdomen fell during the act of expiration.

A great number of authors since this period, particularly our able associate, M. Majendie (*Physiologie,* 2d edition, page 418), have corroborated these circumstances, and have brought in proof of the connexion between inspiration and the quickening of the motion of the blood in the larger venous trunks, new and ingenious experiments, which have confirmed the constant occurrence of this phenomenon. But at the same time, considering it to be merely an auxiliary mean of facilitating the arrival of the venous blood. In fine, although the greatest number of physiologists attributed the progression of the venous blood towards the heart to a vacuum formed in this organ, Bichat (*Anatomie Générale*, tom. i, page 429), very properly observed, that the motion of the blood in the veins still needs much elucidation; for, adds he, notwith-

standing all that authors have written upon this subject, it still presents much obscurity, in which but few gleams of light are perceptible.

We have thought it our duty to enter into these details, in order that the Academy might be able to judge of the Memoir, for the examination of which, M. the Baron Cuvier and I have had the honour of being appointed Commissioners.

In this work Dr. Barry states his peculiar views on the subject of the motion of the blood in the veins. He details minutely the proceedings which he has contrived, we can say, with sagacity; which he has executed upon living animals, with address; and which he was kind enough to repeat several times under the eyes of your Commissioners.

His Memoir presents three principal points of inquiry.

1. To determine by positive experiments, what the power is which forces the venous blood to direct its course, from the most minute ramifications where it has its source, towards the heart, where it empties itself.

2. To appreciate, and to compare, the velocity

with which the blood is moved in the veins, and in the arteries.

3. To prove that the never-failing supply of venous blood to the heart, cannot be solely owing to the causes to which it has been hitherto attributed.

Under the first head Dr. Barry, in studying the phenomena of the venous circulation, has been led to observe that, by the act of inspiration a vacuum is formed within the chest when it tends to dilate its capacity, and that all liquids in communication with the interior of the thorax must be attracted thither, being forced towards it by atmospheric pressure.

All the facts with which we are acquainted, *it must be confessed,* find their explanation in this physical effect. Such are, for example, the swelling of the jugular veins during expiration; their collapse at the moment of inspiration; the cessation of certain hemorrhages by means of forced inspirations; the absorption of air by the veins, and the accidents which have resulted from it, when any of these vessels near the heart have been opened or divided.

The author, not satisfied with bringing these facts as evidence to support his opinion, resolved to strengthen it by direct experiments, of which the following are the principal:—

Having fixed into one of the great veins, such as the jugular of a living animal, one end of a tube, armed with a stop-cock, whilst the other end was plunged in a coloured liquid, he observed, upon opening the stop-cock, that when the animal *inspired*, the liquid was forcibly drawn up; and that during expiration, on the contrary, the liquid remained stationary, if it did not return towards the vessel. We are able to announce moreover to the Academy, that whenever the experimenter introduced the same tube, which was contrived with much ingenuity, into either of the thoracic cavities, or even into the pericardium, the same phenomena were reproduced.

Dr. Barry made use of spiral glass tubes, in order that by increasing the distance which the liquid had to pass over, its motion might be rendered more apparent. He also either mixed with the coloured liquid some drops of oil, or allowed some bubbles of air to enter the tube,

that the ascent of the liquid might be more strikingly perceptible.

In all these experiments, executed with the greatest address, and with such satisfactory precautions, as would obviate all objections which might be opposed to them, the author of the Memoir, the result of which we are anxious to lay before you, fully ascertained, that the sucking action of the great veins was precisely coincident with the instant when the animal endeavoured to form the vacuum in his chest; that the black blood passed through the veins only during the act and the time of inspiration; and that this venous movement was always placed under the influence of the action of atmospheric pressure.

M. Barry is so convinced of the action of the atmosphere upon venous absorption, that he considers the application of a cupping-glass to a recent wound, into the interior of which any deleterious matter may have been introduced, as a certain mean of preventing the absorption of the poisonous matter.

M. Barry attributes also to atmospheric pressure the absorbent action of the pulmonary venoso-arterial system, or of the lesser circulation.

But here the author offers reasonings based upon anatomical structure, rather than upon positive observation; and some facts of comparative anatomy might be successfully opposed to this opinion, which the author has not brought forward with such conclusive experiments as those upon which he has based his demonstration of the action of atmospheric pressure upon the greater venous circulation.

As to the appreciation of the comparative velocity of the blood in the two orders of vessels which it traverses, the author founds it upon the notion that the pressure of the atmosphere is the principal power which impels the venous blood to the heart during inspiration. This blood, therefore, must move with a rapidity which is to that of the arterial blood, as the time employed in one entire respiration, is to the time of a single inspiration. Thus the frequency of the pulse cannot be taken as the measure of the velocity of the blood returning to the heart, because according to the first hypothesis, it would be the repetition of the movements of inspiration, which would regulate this velocity.

This part of the Memoir is entirely founded on

reasoning, and is not supported by such proofs and observations, as would permit us to pronounce an opinion upon this particular point.

With regard to the last consequence, which the author deduces from his Memoir, *viz.*, that the supply of venous blood to the heart cannot be attributed solely to the causes hitherto pointed out; we must declare, that the mere idea of the pressure of the atmosphere being the principal cause, was not first taken up by him. Many others had pointed out this even before Dr. Zugenbhuler, who has thought proper to address a claim of priority to the academy, putting in at the same time a dissertation, *De Motu Sanguinis per Venas*, published in 1815. This author however, although he recognises the action of the pressure of the atmosphere, considers the heart as the first cause of the vacuum which is formed in the system. But M. Barry attributes the dilatation of the heart itself, and of its auricles, to the tendency to a vacuum which takes place in all the cavities of the chest, during inspiration; demonstrating this action by positive experiments, whilst M. Zugenbhuler offers argument only in support of his opinion.

In concluding this report upon M. Barry's interesting Memoir, we feel it our duty to declare, that the experiments described with much detail by the author, have been performed and repeated more than twenty times upon dogs, upon sheep, upon horses; that they have constantly succeeded whenever he was able to bring fairly into operation the ingenious apparatus which he had contrived for the purpose; and that these experimental researches took place under our eyes, at the School of Medicine, at the King's Garden, at the School of Alfort in presence of Mr. Girard, and at the Abbattoirs of Montfaucon.

Your commissioners consider these researches as made in the very best spirit, and as eminently calculated to elucidate the physiological history of the venous circulation in the mammalia.

Under this impression they have the honour to propose to the Academy—that the author be invited to continue his investigations relative to the causes of Absorption, a subject which presents much interest, and the most useful applications to the animal economy; and that M. Barry's Memoir be inserted amongst those of learned strangers.

Your commissioners, however, must not conceal

that in their particular opinion the act of inspiration which appears to produce a vacuum within the thoracic cavities of animals having lungs, such as the mammalia and birds and consequently the attraction of the venous blood towards these cavities, is not sufficient to explain the motion of the blood in the veins of fishes, and of some reptiles, in which the mode of respiration is different. The same coincidence of action not being observed between inspiration (which in these animals is a species of deglutition), and the arrival of the venous blood at the cavity of their hearts.

(Signed) Baron Cuvier,
Dumeril, *Reporter.*

The Academy adopts the conclusions of this report.

Certified to be according to the original.

Perpetual Secretary, Councillor of State, Commander of the Royal order of the Legion of Honour,

Baron Cuvier.

PART II.

ON ABSORPTION.

Chapter I.

Short History of the Ancient and Modern Theories of External Absorption—Imbibition—Comparison of the Ancient and Modern Modes of treating Poisoned Wounds. Influence of these Theories upon Practice.

The progress of our knowledge in the physiology of absorption as exercised by abraded surfaces, is traced in the history of poisoning through superficial wounds. How or when man first became acquainted with this baleful art is hidden from us in the most remote antiquity. It had attained to a degree of perfection, and certainly of effect, long before the date of the very earliest records that have reached us, equal to, if not surpassing what is known to the most enlightened nations of the present day.

The story of the arrows of Hercules dipped in the venom of the Lernæan Hydra—the circumstantial accounts of the sufferings and death of Chiron, Nessus, and Hercules himself, leave no room for doubt upon this subject. They furnish the details of so many direct experiments, proving that men in those remote times knew that certain poisons deposited in wounds were carried into and mixed with the general mass of blood*.

Those to whom we are indebted for these details have unfortunately not recorded any opinion as to the manner in which the mixture of the poison and the blood was thought to be effected. Mankind seem to have been satisfied with the knowledge of the fact, and the practical application of it to the purposes of war and the chase. If any inquiry were made as to the mechanism by which the deleterious substance was removed from the surface towards the centre, no satisfactory account is given of it previously to the times of Celsus and Galen.

* Posse mori cupias tum cum cruciabere diræ
Sanguine serpentis per saucia membra recepto.
Ovid. *Met.* lib. 2.

The advances made in anatomy by these great physicians enabled them to perceive that the veins were the fittest organs through which the matter from abroad could pass into the general system; and as they found these tubes leading directly towards the centre, they recommended that a ligature should be placed above the poisoned wound, if on a limb.

This more enlightened view of external absorption continued to prevail amongst physiolo gists for seventeen centuries, as we learn from Redi, who wrote in 1664. "Ex consilio Galeni fiat strictà ligatura non procul à vulnere in parte superiori, videlicet, ne per sanguinis circulationem, venenum ad cor feratur, totaque sanguinea massa inficiatur*."

As the ancients did not distinguish the arteries, particularly the smaller ones, from the veins, it is probable that all the vessels carrying blood were promiscuously considered as absorbing organs.

The discovery of the true mechanism of the circulation by Harvey, (although it reflected but

* Redi, *de Viperis.*

little additional light upon absorption,) by distinguishing the centripetal from the centrifugal current, must necessarily have excluded the arteries from any share in this function.

Redi must have been acquainted with the theory of the circulation as taught by Harvey, and with the existence of the lymphatic vessels, discovered fourteen years before he wrote ; yet his opinions with regard to external absorption appear to have been exactly those of Celsus and Galen.

It was only about the middle of the eighteenth century that the duties of absorption were first *exclusively* attributed to the lymphatics. The high authority of the Hunters, who taught that these vessels were the only organs employed in conveying matter from without into the system of the living animal, overturned the opinions which had prevailed upon this subject, without having been once questioned for nearly two thousand years.

M. Majendie deserves infinite praise for the able manner in which he demonstrated the error of considering the lymphatics as the sole

absorbents, and the necessity of returning to the sounder doctrine of venous absorption, held by Celsus, Galen, Redi, Ruysch, *&c.* His experiments, without proving that the lymphatics are not absorbents, leave not the slightest doubt that the veins do absorb.

These experiments however notwithstanding their ingenuity, do no more than bring back the question of absorption to the stage of advancement in which Ruysch and Boerhaave had left it, with this difference, that instead of assertion we have direct proof that this function may be carried on by the veins. But the causes which induce or compel the matter deposited on a wounded surface to enter the cavities of the veins, and to mix itself with the passing current of the blood, still continue to be desiderata. Now that tangible facts alone can be received as demonstrations in physiology, the notions of a peculiar unintelligible vital power of discernment and appropriation existing at the ends of the absorbing radicules, cannot even be alluded to.

M. Majendie aware of this, and of the little that his experiments had added to our stock of

knowledge on the subject alluded to, proposed *imbibition**, as sufficient to account for the transfer of matter from the surface of a wound to the current of the venous blood. According to this doctrine the matter placed in contact with a wound, if solid, is first dissolved in the fluids of the part, and when the coats of the vessels are soaked in the solution, that part of it which penetrates to their inside is washed off and carried forward by the current of the circulation.

This would render absorption a very tedious and uncertain process indeed, as we shall see by the conditions required to effect it.

1. There must be a current flowing in the vein through the coats of which the imbibition takes place, else the imbibed matter cannot be washed off and carried forward.

2. If the vein does contain a fluid, the imbibition or passive soaking of its coats may take place at least *as readily* from within outwards as in the opposite direction.

3. The open mouth of a divided or wounded vein

* *Physiologie*, 2 Ed. *Absorp. Veineuse.*

cannot become the subject of imbibition under any circumstances, and if the vessel be collapsed and empty imbibition will take place to no purpose, there being no current to carry forward the imbibed matter.

4. In all wounds minute arterial and lymphatic branches must be divided and laid bare as well as veins, and as there can be no very great difference in the density of their coats, imbibition may take place through the sides of all, and consequently absorption if there be a current flowing through their tubes, but not otherwise.

Thus according to M. Majendie's own shewing, in order that matter shall be conveyed from the surface into the circulation, it is necessary that it be placed in contact with the *outside* of a vein through which a current is actually flowing, and that the coats of this vein shall be incapable of being soaked from within by the contained liquid, while they are ready to be soaked in the same liquid from without, holding the matter to be imbibed in solution.

This last condition of soaking or imbibition of a liquid in one direction only, though applied to

both sides of the same substance, is rather difficult to be comprehended; for if both sides of a sponge be placed in equal contact with water, imbibition will go on towards the centre equally from both surfaces, and will cease when the sponge is saturated. If this simple fact were to be verified in the case of the vein, the poison would never reach the current on its inside. But M. Majendie has most fully and satisfactorily proved that it does reach the current. There must then be some agent beyond mere passive imbibition, to give this unvarying direction from without inwards, to a liquid which, *à priori*, should rather pass in the opposite direction.

Such is the present state of our knowledge of absorption. Some still hold that the lymphatics are the sole absorbents—some that the sanguiferous veins alone perform this function—some that both are concerned in it—all know that absorption does take place. This was known two thousand years ago—Celsus and Galen pointed out the veins as the proper organs—moderns have added or substituted lymphatics.

How much useful knowledge then have we

gained upon this subject in three thousand years? Let us examine the results of the application to practice of the different theories, and see where the advantage lies.

In the very early ages, there appears to have existed no theory on the subject of poisoning from the surface. Men were satisfied with the existence of the fact, and busied themselves only in seeking for a mode of cure.

Philoctetes was restored to health by the skill of Machaon after having been wounded by one of the poisoned arrows of Hercules*; yet Chiron, though himself a teacher of medicine, fell a victim to a similar wound †. The arrow by which Nessus was killed required no poison to effect its purpose, having passed through the centre of his thorax, nor could any antidote have saved him ‡.

* Prop. 2—1, 59.

† In the fourth book of the Iliad, Machaon is made to suck the wound of Menelaus. This is certainly the earliest record of a vacuum having been applied to a wound, whether poisoned or supposed to be so.

‡ ——Et missâ fugientia terga sagittâ
Trajecit. Extabat ferrum de pectore aduncum.
——— Sanguis per utrumque foramen
Emicuit, *mistus* Lernæi tabe Veneni. Ovid *Met.* lib. ix.

As to Hercules, he appears to have been destroyed by a corrosive poison*, and no treatment was had recourse to. Of the two treated, one recovered.

Hippocrates, as far as I can recollect, says nothing of poisoned wounds, although he would seem to make allusion to them in the following passage†.

" *Cucurbitulæ, quæ eum in usum fabricatæ sunt ut ex carne attrahant et avellant.*" In this sentence the first mention of cupping-instruments occurs. If they were used in the cure or prevention of traumatic poisoning, there can be very little doubt that they were supposed to act merely by extracting the deleterious matter *(e carne)* from the wound. The pressure of the atmosphere being then entirely unknown, no theory connected with this agent could have existed.

When the blood-vessels were pointed out as the channels through which the poison passed into the system, the ligature above the wound was naturally thought of, and as the *cucurbitulæ* at-

* ——— " Letiferam conatus scindere Vestem;
" Quâ trahitur, trahit illa cutem——" Ovid *loco citato.*

† Hipp. Sect. I. De Medico.

tracted towards them the contents of these vessels, their utility was rather confirmed than otherwise, for it was evident that the blood flowing from the infected surface would carry with it some portion of the poison which had been deposited there.

Accordingly Celsus, with his usual eloquence and perspicuity, places the cucurbitulæ unequivocally at the head of all preventative and remedial agents in cases of recently-poisoned wounds *.

Talking of the bites of animals, and after remarking that all such wounds are more or less envenomed, he says †,—"*Utique autem, si rabiosus canis fuit, cucurbitula virus ejus extrahendum est; deinde, si locus neque nervosus, neque musculosus est, vulnus id adurendum est.*"

For the bite of the viper, he recommends that a ligature should be immediately placed above the wound. "*Dein venenum extrahendum est.—Id cucurbitula optime facit.*" If, he adds, there should happen to be no cupping-instrument at hand, a circumstance which can scarcely be supposed as likely to occur, "*Homo adhibendus est, qui vulnus exsugat.*"

* Celsus, lib. 5, cap. xxvii. † Loco citato.

These passages, and many others to be found in the same author, fully prove—

1. That the *cucurbitulæ* were the chief, if not in his opinion, the only effectual means to be resorted to for the extraction of poison from wounds.

2. That these instruments were so universally applied to this purpose at the time he wrote, that they were always to be found at hand.

3. That direct suction by the mouth was next to cupping the best preventative, and that either of them was sufficient in cases of viper-bites; for in his directions upon this subject the cautery is not mentioned.

After this the question of priority in the application of a vacuum to wounds inflicted by the bites of rabid and venomous animals, for the purpose of extracting the poison, can be entertained only by the antiquarian, and no man more modern than Celsus can be at all contemplated in the discussion of it.

Strabo, Pliny the elder, Galen, Plutarch, all mention the Psylli, the Marsi, and the Ophigines, as having acquired the reputation of being born with the hereditary power of curing the bites of

venomous serpents. The Psylli, as we learn from Celsus, always sucked the wound. *Ergo quisquis exemplum Psylli secutus id vulnus exsuxerit, et ipse tutus erit, et tutum hominem præstabit.*

Plutarch tells us that when Cato commanded an army in Africa, finding he lost more men by the bites of venomous reptiles than by the arms of the enemy, he hired and attached to his camp a certain number of the Psylli and Marsi, who treated their patients by sucking the bitten part until it swelled. *Et ita, fere semper sanabatur Æger, certo periturus si hac ope abesset* *.

Suetonius informs us that when Augustus saw the body of Cleopatra, who had but just expired from the bite of a serpent, he ordered the Psylli and the Marsi to suck her wounds, hoping that the fair victim might still be restored to life through their exertions.

Redi in his treatment of the bite of a viper follows Celsus to the letter †.

Boerhaave under the head *Antidota* observes, that poison may be removed from the body by

* Boerhaave, Antidota.

† Redi, De Viperis.

various means. Formerly, he says, that which was deposited in wounds was sucked out by the Psylli and the Marsi. In our days, '*hodie per cucurbitulas magnas, validas, sæpe renovatas.*' He was one of the last of the mechanical physiologists, and looked upon many of the phænomena of organized matter as more immediately dependant upon physical causes.

The knowledge acquired about this time of the structure and course of the lymphatics; the opposition set up against the mathematical and mechanical physicians by the supporters of *vital action;* but above all, the absence of direct experiment upon the living animal, produced a total change in the doctrines of external absorption. The lymphatics were now denominated the absorbents *exclusively*, whilst the sanguiferous veins were refused all participation in this function.

The consequent revolution which the treatment of poisoned wounds underwent was equally striking. The cupping-glass was laid aside as too mechanical, or if employed, was considered merely as a counter-irritant. The lymphatics of the part had taken up the poison by a peculiar

vital principle inherent in them. Their action must, therefore, be modified. Stimulants must be given to induce the exhalants to throw off the morbific matter. Irritants must be applied to the wound. That unlucky medical adage, *ubi stimulus ibi fluxus*, was found peculiarly applicable. The discharge was to be kept up by every possible means, whilst the vitality of the absorbents was to be destroyed by caustics. The knife and the heated iron were sometimes used, but more frequently by the unlettered cow-leech than by the learned physician.

Messrs. Vellermé and Trolliet, in a long article on *Rage* in the *Dictionnaire des Sciences Medicales* which is highly creditable to the talents and research of these physicians, do not give a single case in which cupping was tried, although they quote this plan of cure from the ancients. In short, from the days of Celsus to the present, I have not been able to meet with any record of a fair trial having been given to the application of the vacuum, either to the bite of the rabid dog or venomous snake, although every author who

has alluded to either of these subjects invariably mentions *cupping*, but merely as a secondary remedy.

M. Orfila, whose profound researches in toxicology justly entitle him to be considered as the highest modern authority in this department of medical science, in enumerating the preventative measures proper to be adopted in the treatment of the bite of a mad dog, recommends cupping the part, for the purpose of promoting a discharge of blood. In his directions for the treatment of a recent viper-bite, the cupping-glass is not mentioned.

Neither M. Majendie nor his followers appear to have founded any new mode of treatment upon the doctrine of imbibition, as applicable to the prevention or cure of traumatic poisoning. How far the injection of tepid water into the veins of animals labouring under hydrophobia may be conducive to their recovery, or whether this practice be connected with the physiology of living *imbibition,* I confess myself unable to declare.

In this rapid and imperfect sketch of the history of external absorption and traumatic poisoning, there are three epochs.

The first extending from the times of Machaon to those of Celsus. The second from Celsus to Boerhaave. The third from Boerhaave to the present time.

In the records of the first period we find but few and imperfect traces of any theory of absorption, while the treatment of poisoned wounds was hidden and disfigured by the religious absurdities of the day.

The second period is marked at its commencement by sounder physiological views, as to the manner in which the poison deposited in a wound was carried into the system. The blood-vessels were considered the channels through which this transport from the surface to the centre took place. To these vessels, therefore, the curative and preventive treatment were chiefly directed.

Some of the most futile and pernicious administrations however still clung to the practice even of the wisest physicians of these times

such as the re-application of the poisoned weapon to the wound which it had already inflicted*. Yet, notwithstanding this, and many other modes of treatment equally inefficient and absurd, the plan of cure pursued by Celsus in cases of wounds inflicted by poisoned weapons, or by rabid or venomous animals, was beyond all comparison more successful than the mode of treatment adopted by the best physicians of the present day.

A failure in preventing the ill effects of the bite of a venomous serpent when suction had been continuously employed was considered so remarkable, that Ælianus, who wrote in the time of Adrian, took the trouble to record, that a mountebank was bitten in the arm by a serpent (*aspide,*) which he was exhibiting in the Forum during the ædileship of Pompeius Rufus, and that *though he sucked the wound himself,* he died in three days, his gums and palate having first mortified. It was not the death of the man, but

* Vulneri cuspis quod intulit hoc prodest; veneno cuspis illita prodest quibus serpens venenum intulit.—Galen.

the failure of suction in preventing it, that rendered the event remarkable *.

As to hydrophobia Celsus expressly states, that it only occurs when the wound inflicted by the dog has not been attended to; *ubi parum occursum est.*

† The following passage from Celsus will account perhaps for the poor mountebank's misfortune:—" Illud quoque ne interimat ante debebit attendere, ne quod in gingivis palatove aliave parte oris, ulcus habeat.—Lib. 5, cap. ii.

Chapter II.

Can Absorption, strictly speaking, be called a Vital Function?—Definition of Absorption—Why it cannot take place in Vacuo—Its Causes—Proofs that Absorption of Poisons does not take place in Vacuo.

Two of the most powerful and most general agents of nature are gravitation and pressure. Their influence is never for a moment suspended either with regard to living or inert matter: we can conceive no state of organization capable of maintaining an existence independent of their power.

Motion is the effect which renders their operation as a cause perceptible to us. Inert matter moves in obedience to the impulse communicated by them, without offering any resistance of its own by which this impulse can be directed or modified.

Living matter is also moved, but under certain

circumstances it possesses the faculty of modifying the impulse of either or both of these agents, according to the organization peculiar to its mode of existence. The business then of organs as far as relates to these powers, appears to be, to favour one or other of them, to combine, to divide, to oppose them to each other, in short, to modify their operation.

Each organ finds in one or both of these agents, an assistant or antagonist according to the necessity of the action to be performed. Thus the true antagonist to the soaring eagle's wing is gravitation. The fulcrum upon which the wing acts is atmospheric pressure. When the bird stoops upon his prey gravitation is no longer an antagonist, but a powerful assistant to his descent.

When a liquid flows from a compressible tube, or from one open at both ends, if the tube be perpendicularly placed both pressure and gravitation will favour the discharge of the fluid, whilst pressure alone will oppose it; but as the favouring and opposing pressures are equal gravitation will be unresisted.

If pressure be removed from the upper end of this tube, then the gravitation alone of the liquid will be opposed by pressure alone at the lower or discharging end. But as the pressure of the atmosphere is nearly the same at all times, whilst the gravitation of the liquid varies in direct proportion to its specific gravity and the height of its own column, if the sum of these be less than that of the opposing pressure, then the liquid will flow out at the upper opening of the tube, where as pressure has ceased to exist, gravitation alone can offer resistance to the pressure from below.

It is evident that the liquid would have continued to flow out at the lower opening of the tube, if gravitation and pressure had been allowed to remain in their natural relations towards each other; and that to alter these relations in the manner described some third power must have been put in operation. But as inert matter does not *per se* possess this power, although it is capable with its assistance of exhibiting the phænomena just mentioned, it follows that the peculiar and distinguishing privilege of organized

matter, as far as regards these two great agents, does not consist in the phenomena resulting from their modification, but in the self-moved action of the organs by which this modification is produced.

If this view be correct, neither the flowing of the blood through the veins towards the thorax, in direct violation of the immutable law of gravitation, nor the transport of matter by means of this fluid, from the surface to the centre of the living animal, can, strictly speaking, be called a *vital function,* because both are the effects of the modification of pressure, an agent common to all matter. It is that action, or set of actions, by which the modification is produced, to which the epithet *vital* should be attached; because this action is peculiar to living matter possessing an organization such as we at present contemplate.

Thus the word *absorption* representing, in the language of Physiology, the transport of matter from the surface to the centre of a living animal, must be admitted with the same limitations as the word *suction,* conveying, in the language of Physics, the idea of a liquid forced by atmosphe-

ric pressure into a cavity, where, by expansion or otherwise, a tendency to a relative vacuum had been established. Both these terms having been applied to the phenomena connected with them, long before the pressure of the air was known to be the cause of these phenomena, must, in the present state of our knowledge, be considered as equally wanting in philosophical precision, and equally imperfect representatives of the ideas intended to be expressed.

Absorption then, as exercised by living animals, in its physical acceptation, and with reference to matter external to these animals, is the transport of that matter from their surface towards their centre.

According to this definition, when a liquid, such as coloured water placed in an open vessel, mounts against its own gravity through a glass tube having one end immersed in the liquid, and the other inserted into the cavity of one of the great veins within the thorax, the ascent of the liquid, and its flowing into the animal's heart, is a true and genuine act of *absorption*, rendered visible by means of the glass tube, the outer end

of which represents the open mouths of the absorbing veins.

This ascent, or absorption, of the liquid being placed under the influence of atmospheric pressure exclusively, as has been already proved by the experiments detailed in the Memoir on the progression of the blood in the veins, it is evident that, if the liquid were placed under a vacuum, instead of being exposed to the air, it would not flow upwards in the tube, but, on the contrary, would return, provided that the pressure around the extremity in contact with the liquid were rendered less than that around the extremity inserted in the cavity of the vein within the thorax.

Thus the immediate causes or circumstances indispensable to the accomplishment of absorption are reduced to two, *viz.*

1. A free communication between the matter to be absorbed and the thoracic cavities.

2. Atmospheric pressure, modified by the expansion of these cavities around one end of the communicating tubes, while the same pressure is free and undisturbed around the other end.

With these data, and taking for granted that

the sanguiferous or lymphatic veins, or both, are the organs of absorption, their communication with the thorax being exactly the same as that of the tube in the experiment just alluded to, it was natural to presume that the absorption, or transport of any substance, (a poison, for example, deposited in a wound of a living animal,) could not take place if the points of contact of the absorbing surface and of the matter to be absorbed, were placed under the influence of a vacuum.

To prove the truth or error of this induction, I procured different kinds of poison, the fatal activity of which had been well ascertained; such as prussic acid concentrated, pure strychnine, upas tieuté, white oxyde of arsenic, &c. I satisfied myself by repeated trials, that six drops of the acid introduced into the cellular tissue of the thigh of an adult rabbit, would kill him in two minutes—that a grain of pure strychnine deposited in a recent wound of the same animal will produce death in from five to seven minutes, and that a grain of *upas tieuté* will destroy him in ten or twelve minutes.

I experimented with these and other poisons

upon rabbits and dogs, having almost always two animals placed under exactly the same circumstances, except that the piston cupping-glass was applied to one, whilst the other was abandoned to his fate. The animal abandoned invariably perished within the periods stated. The animal, to which the vacuum was applied, never shewed the slightest symptom of poisoning, although the deleterious matter remained in contact with the wounded surface during the space of an hour, two hours, and even so long as five hours consecutively.

When the poison was conveyed by means of a tube under the integuments to some distance from the opening by which it had been introduced, if the cupping-glass was applied to the sound skin, corresponding to the spot where the poison had been deposited (the wound being without the bounds of the vacuum), not only was there no indication that any portion of the poison had been absorbed during the application of the glass, but even after it was taken off the animal continued for one or even two hours to carry imbedded in his cellular tissue a dose which would infallibly

have destroyed him in a few minutes had the cupping-glass not been previously applied.

In these cases, when I waited for the appearance of the tetanic convulsions, the reapplication of the glass immediately suspended them, and the removal of the poison through an incision in the integuments saved the animal.

When I applied the cupping-glass over the opening made in the integuments for the purpose of introducing the tube, leaving the poison under the skin outside the bounds of the vacuum, no absorption took place during half or three-quarters of an hour, but as soon as the glass was removed absorption began.

If, during the application of the glass, I made an incision between its edge and the point where the poison was placed under the integuments, absorption went on as if no vacuum were applied.

Chapter III.

Experiments upon External Absorption—Remarks by M. Andral—Conclusions of M. Laennec's Report.

First Experiment.

On the 12th of August, 1825, at nine o'clock in the morning, in presence of the Rev. Mr. Langley, one of the censors of the University of Oxford, of Dr. Wilson, of the same university, and of M. Miriadeck Laennec, M. D. of Paris, I took two adult rabbits of the same size, and equally healthy. A small wound was made in the skin and cellular tissue of the outside of the left thigh of each. These were filled with precisely equal quantities of impure strychnine; one immediately, the other after an interval of one minute.

After waiting forty-five minutes the rabbits exhibited no other signs of poisoning than some convulsive movements of the muscles of the jaws.

The little wounds were therefore enlarged, and additional portions of strychnine were introduced. Fifteen minutes after the second application, the two rabbits were seized, at the same moment, with convulsions of the most decided tetanic character, which threw their whole frames into the most violent agitation. The spasms lasted some seconds, and returned almost immediately in the rabbit that had been first poisoned, but not so soon in the other.

The piston cupping-glass was now fixed over the wound of the rabbit that had suffered the two convulsions. The other was abandoned to his fate, and died in fifty-five minutes after the second application of the strychnine, having suffered repeated attacks of tetanic spasm and opisthotonos, each exceeding the last in violence and duration.

The rabbit, upon whose wound the cupping-glass had been applied, being placed upon his side, made from time to time some slight struggles, but owing to the forced position in which he was necessarily held, we could not decide whether these movements were convulsive, or merely voluntary.

When the glass, after having been kept on for three-quarters of an hour was removed, and after the wound had been washed, and the rabbit set at liberty, he was seized with a violent attack of true opisthotonos: this lasted about a minute and a half. We all thought him dead, but he recovered with great rapidity, rose upon his legs, and after three-quarters of an hour ate and ran about as if nothing had happened. On the 15th he was again exhibited to the same gentlemen in perfect health, and without having suffered any other attack that I am aware of.

Having read before the Academy of Medicine of Paris a short note containing the details of the above, and some other experiments of a similar nature, that learned body did me the honour to appoint a committee from amongst its members to witness and report upon the repetition of them, and also upon the view I had taken of their physiology.

The committee consisted of the professors Laennec and Orfila, with M. Adelon, secretary to the

Section of Medicine, and author of the work entitled *Physiologie de l'Homme.*

I met these gentlemen at the hospital of *La Charité,* in M. Laennec's amphitheatre, on the 17th of August, 1825, and performed the following experiments. There were present, besides the members of the committee, the celebrated chemists M. Pelletier, Robinet, and Petroz, M. Billery, professor of medicine at Grenoble, and many other physicians and pupils, foreign and French.

Second Experiment.

Assisted by M. Petroz, to whose talents and address I am largely indebted, I took three adult rabbits, and introduced into a wound made in the thigh of each a grain of pure strychnine, brought to the meeting by M. Pelletier, and prepared in his laboratory.

The first rabbit was dead between the fourth and fifth minute. The second rabbit had the cupping-glass applied immediately after the introduction of the poison—the third rabbit at the end of the fourth minute from the deposition of the strychnine in his wound, and after

he had already suffered two attacks of tetanic spasm.

When the glasses were removed after half an hour's application to each, the animals seemed perfectly free from all effects of the poison. The wounds were dressed with sticking-plaster after the poison had been carefully washed off.

Two hours precisely after the removal of the cupping-glass from the wound of the third rabbit, he was seized with convulsions. They yielded immediately to the reapplication of the glass, which was left on for twenty minutes. Neither of the rabbits suffered any other attack, and continued in apparent good health.

Third Experiment.

At the suggestion of M. Orfila (who seemed to think that the salutary effects of the vacuum might be owing to its removing the poison from the surface of the wound), eight grains of the white oxyde of arsenic were introduced deeply under the skin, and into the cellular substance of the thigh of a middle-sized dog. The edges of the

wound were firmly united by suture over the arsenic. The same operation was performed upon another dog of the same size, and with the same precautions. For my own satisfaction, I placed the same quantity of arsenic *superficially* in a wound made at the same point in the thigh of a third dog of equal weight: no suture was used.

Three-quarters of an hour after the insertion of the poison into the thigh of the first dog, the piston cupping-glass was applied. The other two dogs were left to nature.

The vacuum over the wound of the first dog was kept up for five successive hours, during which time the only symptom he shewed of having absorbed any portion of the arsenic was a discharge of saliva rather more copious than natural during the first hour. When the glass was removed, and the stitches cut, the poison was found at the bottom of the wound. The loose skin was cut away, the parts were carefully washed, and the dog set at liberty. He was in perfect health, and continued so for three days, when he was turned into the street.

The increased discharge of saliva was noticed

in both the other dogs. The second whined, and became very uneasy at the end of the first hour after the introduction of the arsenic. Nausea, vomiting, and purging, with tenesmus, came on at the beginning of the third hour. Spasms, convulsions, paralysis of the hinder legs supervened; in short, when we removed the glass from the first dog his case was hopeless: he died in the night.

The symptoms in the third dog came on much earlier after the poisoning, were more intense, and succeeded each other with greater rapidity. According to the accounts of the persons left in charge, he died some hours before the second dog.

The following experiment was instituted with a view to observe the effects of the vacuum not only in preventing absorption, but in mitigating or arresting the symptoms peculiar to the poison applied.

Fourth Experiment.

First rabbit.—Six drops of hydrocyanic acid were poured into a small wound in the integu-

ments of the thigh. At the end of the second minute the animal was dead.

Second rabbit.—Six drops of the same acid were poured into a wound exactly similar to the last. The piston cupping-glass was applied over the wound forthwith. At the end of eleven minutes the rabbit having manifested no symptom of poisoning, the glass was removed in order to observe what might happen. In one minute after this the animal was seized with opisthotonos of so decided a character, accompanied by total cessation of the respiratory movements, that the word *mort* was already written down by M. Adelon; when, as he states in his notes of the experiment, " M. Barry reapplied the piston cupping-glass. In proportion as the sucking effects of the vacuum became more decided, the respiration which had ceased returned, the tetanic spasm became less intense, and more distant in its attacks. At the end of four minutes the rabbit appeared to be perfectly free from the effects of the poison."

Sixteen minutes after this the cupping-glass was again removed. Two minutes after its removal opisthotonos supervened. The glass was a third

time applied, when the spasm immediately subsided. In twelve minutes the glass had fallen off. The convulsions did not return, and the animal continued in perfect health for many days, until he became the subject of another experiment.

Fifth Experiment.

One grain of upas tieuté was introduced through the barrel of a quill, to the distance of about an inch, between the skin and muscles of the thigh of an adult rabbit, where it was deposited, without its having touched the sides of the wound. The little incision through which the quill entered was stitched up, and the cupping-glass was applied upon the sound skin over the poison.

No symptom appeared during two hours that the glass remained fixed, nor for two hours after it had been removed. The rabbit ran about, fed, and appeared in perfect health. At the expiration of this time he was seized with tetanos. The glass was immediately reapplied: the convulsions ceased instantly. After a few minutes application the glass was removed, the upas taken out through an incision made for the purpose, and the parts stained by the solution of the poison were

cut away. The wound was washed and sewed up: the rabbit lived, and did well.

This experiment was repeated with this difference, that the cupping-glass was applied over the external wound, leaving the upas under the skin outside its boundary. No symptom occurred during three-quarters of an hour that the glass remained on, but the moment it was removed the animal was seized with convulsions. These, however, were arrested, and the animal was saved as before.

A third rabbit, poisoned exactly as the two former, and for which nothing whatever was done, died within the eleventh minute after the insertion of the upas.

M. Petroz, with his accustomed ingenuity, who repeated the second variation of this experiment, using hydrocyanic acid instead of upas, reports, that he saved the animal without reopening or washing the part where the poison had been deposited; and that notwithstanding the tetanic convulsions had come on before he could apply

the cupping-glass, he succeeded in saving the animal, by frequently working the piston, volatilizing the acid, and expelling the whole of it through the upper opening of the exhausting syringe, where its characteristic odour was very marked during the operation.

Professor Laennec, who witnessed the whole of these proceedings, drew up a report, in which, after recapitulating the principal experiments, he comes to the following conclusions * :—

"1st. Your committee is therefore of opinion that Dr. Barry's experiments (being the continuation of those by which he has already endeavoured to prove that the venous circulation is carried on principally under the influence of atmospheric pressure) establish, in the most incontestible manner, the influence of this agent on the circulation of the absorbent vessels, the proposition which the author sought to demonstrate.

"2ndly. That the knowledge of this important fact may be considered as a *real discovery*, not-

* Vide Appendix, No. 4.

withstanding the theoretical views and vague ideas entertained by some authors, and the empirical administration of suction to poisoned wounds, a practice more common with half-civilized people than more polished nations.

"3rdly. Your committee proposes that the thanks of the academy be addressed to Dr. Barry, that he be invited to repeat his experiments upon the venom of the viper, that his memoir be inserted amongst those of the academy, and that his name be added to the list of its foreign members.

(Signed) LAENNEC, D. M.

This report having being read at the academy by M. Adelon, it was proposed, that as Messrs. Orfila and Laennec were then both absent from Paris, some new members should be added to the committee, and that further experiments should be instituted for the purpose of ascertaining, if possible, the following points, *viz.:*

1st. Whether the cupping-glass placed elsewhere than over the poisoned wound, or its imme-

diate neighbourhood, would, by acting as a *counter-irritant,* prevent absorption, or relieve the symptoms caused by it.

2ndly. Whether the cupping-glass acts upon the symptoms by recalling to the surface any portion of the matter already absorbed.

3rdly. How long its application may be delayed after the insertion of a given poison, and yet prevent the appearance of the symptoms.

Accordingly, M. Pariset, perpetual secretary to the academy, M. Andral, Jun., and M. Segalas, with M. Adelon, were named as a new committee. In their presence, and at their suggestion, the following experiments were performed. The details are literally translated from the notes taken by M. Andral on the spot.

Sixth Experiment.

" One grain of upas tieuté was introduced into the subcutaneous cellular tissue of the thigh of a rabbit, the wound was closed by a suture. Tetanos came on at the eleventh minute; at the end of the twelfth minute death."

Seventh Experiment.

" One grain of upas tieuté was introduced into the thigh of a rabbit as above. The cupping-glass was applied one minute after, and left on twenty-four minutes. About two hours after the glass had been removed symptoms of tetanos came on. Reapplication of the glass for ten minutes—immediate cessation of the convulsions—poison removed from the wound—parts washed—animal restored to health."

Eighth Experiment.

" Introduction of a grain of upas into the thigh of an adult rabbit as above. *Three* minutes after the glass was applied, and left on twenty-four minutes. Poison removed, wound carefully washed: no symptoms."

Ninth Experiment

" One grain of upas introduced as before into the thigh of a full-grown rabbit. *Six* minutes

after the cupping-glass was applied, and left on twenty-four minutes. Wound treated as in last experiment: no symptoms."

Tenth Experiment.

"The last experiment repeated upon another rabbit. Glass applied *ten* minutes after the introduction of the poison, that is, less than one minute before the period when the symptoms of poisoning began to appear in the first rabbit. The glass was left on twenty-four minutes. No symptoms: wound treated as before."

Eleventh Experiment.

"Injection of six drops of hydrocyanic acid *(au quart)* into the cellular tissue of the thigh of an adult rabbit. In one minute convulsions, in two death."

Twelfth Experiment.

"Similar injection in another rabbit. Convulsions rather before the end of the first minute.

Application of the glass: immediate cessation of the spasms, and permanent restoration to health, as in the other experiments."

Thirteenth Experiment.

" Introduction of *four* grains of upas tieuté into the thigh of a small dog. The piston cupping-glass was applied at the same time to a similar wound on the corresponding part of the opposite thigh. Symptoms of poisoning at the end of eight minutes: these soon acquired such a degree of intensity that the animal was upon the very point of expiring. In this state of extreme suffering the cupping-glass was removed to the poisoned wound, and the vacuum established. Instantly the symptoms were alleviated. The animal was truly recalled to life; but from time to time he still suffered slight attacks of tetanos. After a quarter of an hour's application the glass was removed, and the animal appeared restored to health *."

* This animal was found dead some hours after the glass had been removed.

Remarks by M. Andral.

"In this case the cupping-glass appears to have moderated the symptoms by arresting all further absorption of the poison; but that which was already in the circulation does not seem to have been recalled to the surface of the wound, because the symptoms continued, although mitigated; unless we choose to suppose that the continuation of the convulsions was owing to the impression already made upon the nervous system. On the other hand, the animal economy does not rid itself of deleterious substances so promptly as is generally thought: this the following experiment would seem to prove."

Fourteenth Experiment.

"One quarter of a grain of pure strychnine dissolved in two ounces of distilled water was injected into the trachea of a middle-sized dog. For several hours after the animal showed by the stiffness of his limbs, and by a convulsive agi-

tation from time to time, that he was still under the influence of the poison."

Fifteenth Experiment.

"With a view to observe whether the cupping-glass acted by bringing back to the surface any portion of a substance introduced into the cellular tissue by injection, we injected into the subcutaneous tissue of the inside of the thigh of a dog about two drachms of a saturated solution of the *sulfate of soda.* The wound was carefully wiped, and the glass applied. After working the piston a few times, we found the salt, by means of a proper test, in the reddish liquid which the pressure of the air had forced into the glass."

The above and many other analogous experiments were repeated and varied before many French and foreign physicians, but never exhibited the slightest anomaly.

CHAPTER IV.

Experiments upon the Bite of the Viper.

FOR the purpose of giving a more useful application to this method of preventing poisoning by external absorption, I had several dogs and rabbits bitten by vipers, of which I had procured a considerable number from Grenoble and Fontainbleau. To the bites of some I applied the cupping-glass, to the bites of others nothing; and although the animals abandoned did not ultimately perish, the results obtained by the comparison were precisely analogous, as far as regards the symptoms, to those observed in the preceding experiments, that is, the animals bitten by one, two, and sometimes three vipers, when the cupping-glass was applied for half an hour, suffered no symptom whatever of constitutional poisoning; whilst those that were left to nature

were invariably attacked with convulsions, stupor, and the dogs by vomiting.

Pigeons invariably perished from one bite of the ordinary viper of Fontainbleau, exhibiting, when left to nature, the commencement of the fatal symptoms before the fifth minute; but when the cupping-glass was applied immediately after the bite, they not only shówed no signs of having absorbed the venom while the glass remained on, but eventually escaped when the treatment to be noticed hereafter was adopted.

The local action of the viper's venom, mentioned by Fontana, so marked and so rapid in its effects, seems to be concentrated by the cupping-glass within its own bounds, particularly in dogs, but is entirely prevented in rabbits. This difference is owing to the different density of the skins of these animals. The vacuum sucks a reddish serum in considerable quantity through the skin of the latter, whilst very little or nothing is forced through the skin of the former.

Experiments made with living Vipers upon Dogs, Rabbits, and Pigeons.

Sixteenth Experiment.

On the 29th of September, 1825, in Baron Cuvier's anatomical laboratory, where, with his usual condescension, he was kind enough to permit me to avail myself of the talents and dexterity of M. Rousseau, Jun., one of his principal preparators, a large viper was applied* to the thigh of a half-grown weakly rabbit. The reptile bit twice: a minute drop of blood marked each puncture made by the fangs. One minute after the bites the piston-glass was applied upon the bitten part. M. Rousseau, who held his eye close to the glass whilst I worked the piston, observed a drop of transparent amber-coloured liquid issue from each of the punctures. This was followed by a considerable quantity of

* M. Rousseau applied the vipers by seizing them with a long forceps behind the posterior projecting angles of the head, and placing their nose in contact with the part intended to be bitten: they never failed to bite as often as we wished.

reddish serum, which rose into a thin froth, and in fifteen minutes nearly filled the glass with its large transparent bubbles. The vacuum was kept up for thirty-five minutes. When the rabbit was set at liberty he appeared to suffer no inconvenience: the little wounds presented nothing remarkable.

One hour after this rabbit had been bitten the same viper was presented to the thigh of another, which he bit twice also, drawing blood as before. The second rabbit was larger and much stronger than the first. A pale yellow spot was noticed almost immediately around each puncture made by the fangs. When the animal was set at liberty the bitten leg appeared slightly paralyzed. Ten minutes after the bite, the whole integuments of the bitten part appeared livid. Half an hour after, the lividity was intense, and had extended to the circumference of half a crown.

The next day an open gangrenous ulcer occupied the whole of the livid circle, discharging a fetid sanies. The leg and thigh were swelled. Forty-eight hours after the bite, the ulcer was

still open, but not so fetid. Seventy-two hours after the bites, the ulcer looking healthy, the limb reduced.

During all this time, the rabbit first bitten never showed the slightest symptom of either local or general poisoning. The second rabbit refused his usual food during the first thirty hours after he had been bitten, and looked dull.

Seventeenth Experiment.

On the 13th October M. Rousseau, with his accustomed dexterity, applied two large fresh vipers to the thigh of a middle-sized dog. The part had been previously shaved. Each viper bit twice with eagerness. Two minutes after the first bite, a cupping-glass was applied over the punctures. Dr. Edwards, who honoured this experiment by his presence and assistance, observed several drops of a yellowish-red fluid, oozing from the little wounds inflicted by the viper's teeth.

The glass remained fixed thirty minutes, and was then removed. Some very slight scratches,

which did not go through the skin, having been made with a razor, the cupping-glass was again fixed on, but the quantity of blood extracted did not exceed a drachm and a half.

At the end of forty minutes from the commencement, the glass was finally taken off, and the part washed. Large livid spots were distinctly perceived around the wounds inflicted by the fangs.

The dog did not appear to have suffered the slightest inconvenience from having been bitten. He ate and drank. Twenty-four hours after the bite there was still no symptom either local or general. On the second morning a gangrenous eschar was found to occupy the whole of the integuments which had been included in the cupping-glass. The leg and thigh were swelled, but the general health of the dog seemed unimpaired. His lameness was scarcely perceptible; in short, the eschar was thrown off in a few days, leaving a clean sore, which healed soon after; and the animal recovered without any other symptom than those mentioned.

Eighteenth Experiment.

To ascertain whether the vipers used in this experiment were really venemous, one of them was presented to the breast of a young pigeon, and suffered to bite *once.* Although this was the third bite made by the reptile within an hour, the bird showed symptoms of being affected by the poison at the third minute, fell on his side at the fifth, and died at the end of the twentieth minute after he had been bitten.

Nineteenth Experiment.

Another dog of the same size as the subject of Experiment No. 17, was also bitten by two large vipers, and exactly in the same manner. He showed strong symptoms of suffering about the eighth minute after the bites, uttered plaintive sharp cries, and became excessively restless. At the fifteenth minute made violent efforts to vomit; vomited abundantly at the twentieth; then lay down upon his side at

full length in a kind of stupor. In this state he continued the whole of that day, refusing food and drink.

Next morning the bitten leg was much swelled. The parts livid; ulceration already commencing. The animal dull, dejected, and difficult to be roused. After extensive gangrenous ulceration he recovered, but very slowly, and was much emaciated.

Twentieth Experiment.

On the 24th October two adult rabbits were bitten, each by three vipers, and by each viper three times. To one of these rabbits I applied the cupping-glass, which was left on thirty minutes. In this as in No. 16, I observed a considerable quantity of serous fluid ooze through the skin, and afterwards expand into thin froth with very large bubbles, filling the glass. I now dissected out the skin and cellular substance which had been included under the glass, applying the vacuum again for ten minutes; after which the

wound was washed and the lips of it brought together by suture. The rabbit when set at liberty appeared to be in perfect health.

The other rabbit had been left to his fate. On the 25th, at five in the afternoon, the cupped rabbit was as well as if nothing had happened to him: the wound in the thigh looking exactly as if it had never been touched by a viper's tooth, and inclining to heal.

The rabbit that had been left to nature hung his ears, and looked very dull: the bitten thigh was much swelled, whilst a large gangrenous livid phlyctena, filled with a thin sanies, occupied the whole of the bitten part.

On the 27th, the cupped rabbit in excellent health: the wound healing without any appearance of gangrene. The phlyctena in the other rabbit had degenerated into an extensive fetid ulcer. This animal after much suffering finally recovered.

Twenty-first Experiment.

In presence of M. Dumeril, professor of physiology, a young pigeon was bitten twice over the

pectoral muscle by a very large viper. The cupping-glass was applied immediately after the second bite, and left on *eight minutes only.* Nothing else was done. No symptoms of poisoning occurred for fifteen minutes after the removal of the glass, when the bird began to stagger. In a few minutes he fell upon his side, his respiration becoming remarkably slow. This pigeon was dead at the expiration of an hour and sixteen minutes after the second bite. About fifteen minutes before his death, the cupping-glass was again applied, but produced no visible effect.

A second pigeon had been bitten by a very small viper twice, exactly in the same place as the first. Five minutes after the first bite he showed the usual symptoms of poisoning, such as inability to stand, falling on the bitten side, slight convulsions. He died at the end of the fifty-fifth minute from the first bite.

Dissection.—Upon examining the bitten parts of both pigeons, the whole of the great, and a large portion of the lesser pectoral muscles were livid, tender, and almost decomposed in the pigeon that had not been cupped. The correspond-

ing parts in the cupped pigeon were perfectly natural, with the exception of two livid spots which we traced around two distinct veins, into the thorax. The intestines of both pigeons presented traces of recent and active inflammation with livid vascularity.

Fontana lays it down as a law, in poisoning by the viper's venom, *that the longer the animal has survived the fatal bite, the more intense are the lividity and decomposition of the bitten parts.* In this experiment the reverse was strikingly manifest.

Twenty-second Experiment.

On the 5th November, in Baron Cuvier's laboratory, and in presence of Messrs. Rousseau, father and son, a small-sized old dog was bitten in the thigh by three vipers, and by each viper three times. The reptiles had been previously much excited. Three minutes after the first bite the piston-cupping-glass was applied and kept attached for fifteen minutes. It was then removed, and the whole of the skin and cellular substance, down to the muscle, which had been included, within the vacuum, was removed by the knife. The

glass was again immediately applied over this fresh wound, and kept on for fifteen minutes longer. The parts were now carefully washed. Some little bits of livid cellular substance were removed. The lips of the wound were brought together by suture, and the dog set at liberty. Not the slightest symptom of poisoning appeared about the animal. Two hours after his wounds had been dressed, he escaped from the servant, and ran with such vigour as to leave his pursuers no chance of coming up with him.

Twenty-third Experiment.

On the same day M. Rousseau, junior, presented a very large viper, which had been particularly excited, to the bare breast of a young pigeon, three-quarters grown. The viper bit deeply and eagerly *once*. Both the little punctures made by the fangs were marked, each by a small bloody stain. The piston-cupping-glass was applied forthwith. Two amber-coloured drops were now seen to issue from the little wounds already noticed, and were very soon followed by minute quantities of very dark-coloured blood. The glass was kept

on fifteen minutes. The livid parts around the little punctures were now dissected out. A gangrenous phlyctena had already formed, containing a thin ichor. After the infected parts had been removed, the glass was again put on for ten minutes. Again the glass was removed, and a small portion of muscle, or rather of a livid vein running into the muscular flesh, was dissected out. Not the slightest symptom of poisoning appeared. The pigeon walked upright and seemed in perfect health.

9th November.—The pigeon has continued to enjoy good health, and was this day shown to M. Rousseau. The following is his note:—

"J'ai vu le pigeon que nous avons fait mordre le samedi cinq de ce mois. Ce même pigeon est très bien portant le neuf. Au Jardin du Roi, le 9 Novembre, 1825."

Fontana states that amputation of the pigeon's leg *three or four seconds* after it has been bitten by a viper, saves the animal; but if the operation be delayed *one minute*, however high above the bite it may be performed, instead of saving the animal, it hastens his death.

CONCLUSIONS.

From these experiments, and from the uniformity of their results, we may consider the following facts as proved :—

First.—That neither sound nor wounded parts of the surface of a living animal can absorb when placed under a vacuum.

Second.—That the application of the vacuum by means of a piston-cupping-glass placed over the points of contact of the absorbing surface, and the poison which is in the act of being absorbed, arrests or mitigates the symptoms caused by the poison *.

Third.—That the application of a cupping-glass for half an hour deprives the vessels of the part over which it had been applied of their absorbing faculty, during the hour or two immediately succeeding the removal of the glass †.

Fourth.—That the pressure of the air forces into the vacuum, even through the skin, a portion of the matter introduced into the cellular tissue

* Vide Exp. No. 4. † Vide Exp. No. 5.

by injection; that is, if the skin of the animal be not too dense, as in the dog. (Exps. 16, 20.)

From these facts we again arrive at the con clusions already established by the experiments detailed in Part I., viz.,—

1st. That *the taking up* of matter from the surface by the sanguiferous and lymphatic veins, and the progression towards the heart of the contents of these vessels, are placed under the influence of atmospheric pressure, in all animals possessing thoracic cavities, and exercising over them the power of alternate contraction and dilatation around that point to which the centripetal current of their circulation is directed.

2d. That, as the veins and lymphatics communicate with the thoracic cavities nearly in the same manner, the cardiac ends of both must be exempt from atmospheric pressure when the thorax is expanded, and therefore the pressure on the surface and extremities of these vessels being unresisted at this moment, except by gravitation, must not only press their contents upwards, but also force matter from abroad into their open mouths, or

porous sides, when stript of their more dense çoverings.

3rd. That as the height of the column of lymph exceeds that of the column of blood in the lower cava, by the distance from the lower point of the right auricle to the upper part of the subclavian vein in man, and as the course of the lymph is more tortuous and indirect (from passing through glands) than the course of the venous blood; it follows, that the velocity of the transport of matter from the surface to the centre, must be less in the lymphatic, than the sanguiferous veins, and that the comparative quantity transported by the two sets of vessels must be influenced by the circumstances already noted, and by the relative capacity of the vessels themselves. The difference in the specific gravities of blood and lymph should, perhaps, be also taken into calculation.

4th. That as *imbibition, transudation, or passive soaking* of a part in a liquid may take place *in vacuo,* neither can be the agent which induces or compels matter deposited on the surface to penetrate into the cavities of the veins; for although the

cupping-glass may arrest the current of the circulation in the smaller vessels during the period of its application, and even for some time after its removal, yet if imbibition could force the poison, which had been lying in the wound for hours, into their tubes, the washing of the part after taking off the glass would not save the animal from the effects of a substance which with the simple contact of the atmosphere would have killed him in a few minutes.

Chapter V.

Comparative Absorbing Powers of the Tissues.—Morbid Poisons.—Contagion and Infection.

Seeing, then, that atmospheric pressure favourably modified, and a free communication with the thoracic cavities, are the two indispensable requisites to enable any part to accomplish the function of absorption, we might *à priori* conclude, that the absorbing powers of the different tissues stand in direct proportion :—

1st. To the pressure to which their veins are exposed.

2nd. To the freedom of communication with the thoracic cavities.

3rd. To the permeability of the mouths and coats of the veins.

4th. To the number of the veins.

Accordingly we find that the membrane or tissue in which the air-cells of the lungs are formed absorbs with the greatest rapidity, because it unites in the most perfect degree the above con-

ditions. Its veins are the most numerous. Their communication with the central cavity of the thorax is the shortest and most direct. Their coats are the most pervious ; whilst their contents are forced forward by the whole pressure of the air rushing down the trachea during inspiration, increased by rarefaction and the resistance of the bronchiæ and air-cells.

Twenty-fourth Experiment.

One grain of alcoholic extract of nux vomica, dissolved in two ounces of distilled water, and injected through the trachea into the lungs of a dog, produced tetanic spasm of the limbs and opisthotonos within the tenth *second* from the commencement of the injection, and death in less than two minutes. He breathed freely after the syringe was removed.

A similar quantity of the same liquid was injected through a stop-cock, which had been previously fitted into the trachea of another dog, and the stopper was turned the moment the

injection was completed. The symptoms came on some seconds latter. Opening the stop-cock, and allowing the animal to breathe, did not protract his existence.

Twenty-fifth Experiment.

One ounce of alcohol was injected into the jugular vein, towards the heart, of a full-grown fox-hound. In a few minutes he appeared to be profoundly intoxicated. Half an hour after this operation, when the animal began to recover, but whilst he was still breathing slowly, as if apoplectic, *four* grains of spirituous extract of nux vomica, dissolved in six ounces of distilled water, were injected into his lungs, through an opening made in the trachea. Ten seconds after the completion of the injection, he was seized with strong tetanic convulsions. At the end of the third minute he appeared to be quite dead; at the fifth minute respiration returned, and with it the convulsions. Each convulsion pulled back his head, stretched out all his limbs stiff and separate, and lasted exactly during the act of inspiration. In expiration

the spasm relaxed, but invariably returned with each inspiration. This coincidence of the tetanic spasms with inspiration continued six minutes, the spasms becoming more and more distant as the respiration became slower, until death closed the scene.

At the opposite extremity of the scale of absorbing tissues stand the ossesus, the fibro-cartilaginous, the epidermoid. In these there is no absorption, although there may be *imbibition.*

Fontana could never succeed in producing any effect by the application of poisons to the bare insulated nerves of living animals.

Between the extremes of the scale are ranged the subcutaneous cellular tissue, the visceral mucous*, the serous, and other tissues lining cavities.

The conjunctiva absorbs freely, because its vessels are numerous, their coats thin, and exposed to full pressure.

* The peculiarities attached to the absorbing powers of this tissue are reserved for a separate paper.

Pliny the Elder has recorded a very curious observation with regard to the membrane lining the female parts of generation *, and although it is calculated to throw the most important light upon a very interesting point of legal medicine, I am not aware that it has been noticed by any writer upon that subject.

These experiments account for the communication of disease without contact. The infective matter of small-pox is more abundantly and more fatally taken into the system by breathing the atmosphere of the variolous, than by inoculation —the plague, by inhaling the effluvia of the pest-house. In short, whatever poison is capable of being suspended or dissolved in the air as a menstruum, must inevitably pass into the blood of those who respire this air thus infected. "Qui

* Cum constat omnium venenorum ocyssimum esse aconitum [a]. Tactis quoque genitalibus fœminini sexus animalium, eodem die inferre mortem. Hoc fuit venenum, quo interemptas dormientes, a Calpurnio Bestia, uxores, Marcus Cæcilius accusator objecit. Hinc illa atrox peroratio ejus in digitum.—*Plinius Secundus*, *Hist. Nat.* lib. xxvii.

[a] Aconitum, supposed to be a compound similar to the hunting-poison of the Gauls.

cum non respirare non possunt, contagium miseri, evadere nequeunt*."

Certain states of the atmosphere connected with heat, moisture, agitation, electricity, &c., may enable it to hold in suspension a greater or a less proportion of morbific matter. The quantity absorbed by those who respire it must stand in direct relation to the quantity thus applied to the mucous surface of their lungs.

1st. Some poisons are incapable of being dissolved in the atmosphere, at least in sufficient abundance to produce their usual effects upon man. Such are the vaccine virus, and, generally, all those peculiar to the brute creation.

2dly. Some poisons cannot be sufficiently concentrated to affect the system through any other surface than that of the air-cells of the lungs. Such are the deleterious gases and effluvia.

3dly. Some are capable of infecting through all vascular tissues, but most fatally through the lungs, owing, perhaps, to the greater extent of surface to which they are there applied, and to

* Galen, 5ᵃ. 96 G.

the other circumstances just noticed. Such are the virus of small-pox and plague.

The specific morbid poisons of the first and second classes are limited in their effects to certain surfaces. Those of the third class are unlimited. None, however, can communicate disease, even supposing all other things favourable to its developement, without the existence of one condition, indispensable alike in all cases, *viz.*, the contact of the poison with the surface through which it is to pass into the circulation.

But to bring about this contact between the lungs and the virus of small-pox or plague, a certain approach must be made towards the source of infection; for it is only around this source that the atmosphere can be so charged with the infective matter as to afford sufficient for respiratory absorption.

If the air around an infected individual, or bale of goods, could be so impregnated with the emanation of variolous or plague virus, or with the germs of any other disease whatever, as the distilled water was with nux-vomica in the 24th and 25th experiments, there cannot exist even a sha-

dow of a doubt that a sound individual respiring that air, would be more rapidly and more abundantly poisoned than he could be by inoculation.

If one infected individual cannot furnish enough of virus to charge the atmosphere around him with the seeds of his disease, we know that a greater number can; and if the air be not disposed at one time to hold these germs suspended, we know that at other times it is so disposed. Therefore, whilst men have lungs constructed as these organs are at present—whilst the mucous surface of these lungs *are* exposed to the contact of every thing the atmosphere holds in solution—and whilst it is certain that the most fatal poisons may be thus deposited on the most rapidly-absorbing tissue of the whole frame, the healthy should be carefully and distantly separated from the infected; nor should they ever, under any circumstances, respire the air which the emanations from the latter may have poisoned.

From what has been said on the subject of specific morbid poisons, may be seen the incorrectness, nay, even the dangerous tendency of the

L

distinction lately attempted to be established by some writers, between *contagion* and *infection.*

If contagion be considered as having reference only to the necessity of *contact* between any of the specific poisons and an absorbing surface, then all the diseases communicated by morbific matter, whether solid or gaseous, must be ranged under the head of *contagious.* But if it refer to the presumed necessity of contact between sound and infected individuals, then none of the diseases alluded to can be called contagious, because this kind of contact is in no case necessary to their being communicated.

The word *infect* and its derivatives clearly convey the idea of something noxious introduced into the system. They admit of no quibbling ambiguity, and should, in sanatary logic, universally supersede the use of the word contagion and its adjectives.

Chapter VI.

Application of the foregoing Principles and Experiments to Practice in the Treatment of Poisoned Wounds.

In applying the principles developed in the preceding reasonings and experiments, to the prevention and cure of the symptoms usually produced by the absorption of deleterious matter deposited in a wound, or on an abraded surface,—I shall consider, first, those cases in which the poison is simply placed in the wound, and does not exercise any local action on the tissues of the part.

Secondly, Those cases in which the poison is injected into the parenchyma, or vessels of the part, and when some local action is visible.

Thirdly, That unique variety of poisoning produced by the bite of the rabid dog.

My observations as to curative and preventive

measures shall be confined to such as are entirely physical and external.

These are, 1st, The ligature between the poisoned wound and the heart. 2d, The cupping-glass, or vacuum. 3d, Excision and scarification. 4th, The actual cautery. 5th, Protection from atmospheric pressure.

1. In all cases of superficial poisoning, when the deleterious matter is simply deposited in the wound, the application of the cupping-glass over the point of contact will save the individual, provided it be made with the precautions to be noticed hereafter, and before a dose sufficient to cause death shall have been absorbed.

2. In cases where the poison has been injected, as, for instance, by the hollow fang of a viper or rattlesnake, though the cupping-glass may have been applied, yet as the local action of the venom goes on in vacuo, the parts acted upon should be cut out after the venom has been concentrated and partly extracted by the cupping-glass, which should be immediately reapplied over the wound made by the knife, for the purpose of extracting the contents of the newly-divided vessels from a

greater distance than could be done before the operation. After this the actual cautery may be administered, if thought necessary; but never under any circumstances before the second application of the cupping-glass, for this reason,—that when the mouths of the vessels are hermetically sealed by the hot iron, they can give out nothing to the vacuum.

3. The poisoning that results from the bite of a mad dog, so far as regards the simple deposition of the deleterious matter in the wound, and the total absence of local action upon the wounded tissues, comes strictly under the first, or least complicated class of cases. But the tardiness with which the poison is absorbed, or if absorbed, with which it produces its peculiar effects, entitles it to be considered as a species *sui generis*.

Fortunately this anomaly does not alter the preventative indications. These are purely physical, and as such must be ever unvaried. The first thing, then, to be done in treating the recent bite of a rabid dog, is to apply a powerful cupping-glass over the wound. This measure supersedes at once the ligature, ablution, exci-

sion, *&c.*, during the period of its application, and for a certain time after its removal *. 2. After the cupping-glass has been applied for an hour *at least*, the whole of the parts wounded or abraded by the bite should be freely dissected out. 3. The cupping-glass should then be reapplied immediately for the reasons already stated. 4. The wound should next be hermetically sealed by the actual cautery. 5. The part should be as little exposed to the contact of the air after the slough comes away, and as soon healed up, as possible.

If the first application of the cupping-glass shall have so concentrated the poison, as that the excision of the part will remove it, or if the second application of the glass shall have recalled such particles of it as may have been forced into the wounded vessels too far to be reached by the knife, but not beyond the limits of the influence of the vacuum, the individual will be as secure against hydrophobia as if he had never been bitten. But if the poison has already been transported into the circulation, there to undergo its

* Experiments 5—7.

incubation, it is evident that no external measures can be of use.

The notion that the hydrophobic poison is absorbed after the manner of other substances similarly circumstanced, but that it does not produce its peculiar effects, until it has wandered through the *penetralia* of the animal for forty days or longer, is in direct opposition to all analogy.

The experiments which we have witnessed with the vegetable, mineral, and reptile poisons, applied to animals externally, prove that the commencement of the symptoms is synchronous with the consummation of the absorption, and that their repetition is dependant upon its renewal.

When the hydrophobic wound has been cicatrized, previously to the appearance of the symptoms, we almost always find that it either opens again by ulceration, or that a painful line is felt extending from it towards the thorax. Indeed, both these circumstances are often observed. Hence arises a strong presumption that it is only at this moment the fatal absorption commences, and that, as we have seen in experimental poisoning, the completion of the first act of absorp-

tion is soon followed by the appearance of the disease peculiar to this species of infection.

In order that specific constitutional disease should be produced by the application of an animal poison to a wound, it is necessary, 1st, That the quantity of the poison be increased by the assimilation, to a certain extent, of the matter with which it is placed in contact. 2d, That this augmented, or assimilated virus should be carried into, and mixed with the blood, and that the whole mass of the circulating fluids should be thereby contaminated.

The first of these conditions is observed when syphilitic, variolous, vaccine, or glanders-poison is applied to an absorbed surface.

The second is proved beyond all question, by the admirable experiment lately made by Professor Coleman. He transfused some of the blood of a glandered horse into the veins of a sound horse, and thus communicated the disease.

This experiment alone would entitle Mr. Coleman to hold that high rank amongst the physiologists of Europe, which he so eminently occupies amongst those who know him, or have

enjoyed the opportunity of hearing his highly-interesting lectures on the physiology and pathology of the horse.

Under the presumptive impression, then, that in hydrophobic, as well as in all other species of poisoning, the transport of the deleterious matter from the wound into the system, and the appearance of the symptoms peculiar to the poison, follow each other as cause and effect—as soon as the cicatrix begins to feel at all tender, or when there is sufficient evidence that the animal which inflicted the bite was rabid, we should immediately apply the cupping-glass, and proceed exactly as in the case of a recent bite; nor should the actual presence of hydrophobia deter us from this proceeding, any more than the presence of tetanic spasm in repeating the Fourth Experiment.

It may here be asked, how is it that the cupping-glass should now rank so low as a measure of prevention or cure in poisoned wounds, whilst its character remains unimpeached from the time of Celsus, the day of its supremacy, up to the present hour?

The answer is, that as the true mechanism of absorption was never understood, nor ever thought to be connected with atmospheric pressure, the *ratio medendi* of the vacuum must have been but imperfectly comprehended, and therefore the circumstances which might promote its success, or contribute to its failure, could not have been duly appreciated.

As the laws presiding over physical causes and effects must ever have been, and must ever remain the same, the failure of the cupping-glass when it ought to have saved the individual, can only be attributable to improper interference with the poisoned wound previously to its application. This interference usually consisted; 1. In scarifications, which might or might not extend beyond the area to be covered by the mouth of the glass. 2. In the actual or potential cautery. 3. In free exposure to the air.

Celsus recommends surrounding the wound with incisions or scarifications before the cucurbitula is placed over it. "*Neque alienum est ante scalpello circa vulnus incidere.*"

Galen to this preparatory measure adds the ac-

tual cautery. " *Scalpello circumcide vel igne amputa, ventosam post hæc ni locus vetat infer* *."

Here are two records fully proving that the vacuum could not always have succeeded even in the hands of Galen, although applied with due promptitude after the insertion of the poison.

If it be an object to impress a retrograde direction upon the fluids connected with the wound, and thereby recall to the surface any particles of the poison which may have already entered the mouths or pores of the divided vessels, it is evident that the more exclusively the pressure is directed to the wounded surface, and to the little vessels connected with it, the greater will be the probability of their contents being squeezed out into the vacuum: it being an invariable law, that of many things equally pressed, that which requires least pressure to be moved will yield first, and move in the direction where there is least resistance.

Now, when the soft parts about a wound, however minute, are forced into the vacuum of a cupping-glass, the point which offers the least resistance

* Galen, (5 ª, 96 G.)

to the exit of the fluids contained in these parts is the little wound itself. But if scarifications have been made around it, it is no longer so. Therefore the balance between the vacuum within the glass, and the pressure without, will tend to be established by a discharge from the scarifications, and not from the original wound. Hence the probability of the poison being forced out of the wound and the vessels around it, will be diminished in proportion to the magnitude of the scarifications.

If these scarifications extend beyond the area of the vacuum, the contents of the vessels thus divided will cease to be influenced by it, and therefore whatever portion of the poison may have passed beyond the point of division, will be carried to the heart, as if no vacuum had been applied.

If actual or potential cauteries shall have been used, and if any portion of the poison remain beyond the depth to which their action may have extended, the application of the vacuum will be perfectly useless, because the openings through which the poison might be pressed out are sealed up.

The adoption, then, of any preparatory measure previously to the application of the vacuum to poisoned wounds, must deduct from the probability of success, as well by the countervailing effects of the measures themselves, as by the loss of time they occasion. The ligature, recommended by Celsus to be placed between the wound and the heart, but not so tightly as to deprive the limb of sensation, should, with simple ablution of the part, and protecting it from the contact of the air, be the only remedial measures ever suffered to precede the application of the vacuum; and even these, only when a cupping-glass or suction by the mouth cannot be immediately commanded.

Excision and cautery can be of use only in proportion to their extent. If they reach beyond the poison they will certainly save, but not otherwise. The particles which had been already forced further than the boundary of the excised wound, will be sent to the heart with greater rapidity after the operation than they otherwise would have been*, owing to the wider mouths of

* Fontana, Experiments upon Pigeons.

the vessels being now fully exposed, and open to receive the atmosphere within their cavities.

When the cupping-glass has been applied for an hour to the poisoned part, previously to removing it with the knife, the contents of all the vessels will have acquired a retrograde direction, and from not being permitted to flow freely into the vacuum, a perfect stasis of the fluids is established; hence the loss of the absorbing faculty of the cupped surface already noticed. (Experiments 5—7.)

Thus by allowing the first cupping to precede the excision of the part, not only is there a greater quantity of the poison removed, but the danger of a more rapid absorption is avoided, whilst the certainty of extracting a still further portion, or, perhaps, the whole of what may have remained, constitutes an additional and important advantage to be obtained by the second cupping *.

The advantage to be derived from the actual cautery, after the excision and second cupping, is also of a strictly physical nature. The

* Experiments 22, 23.

burning of the little vessel hermetically closes its mouth, and renders its tube incompressible for a certain extent. Its absorbing powers, therefore, are suspended, because the pressure of the atmosphere can neither force any thing into it, nor compress it upon its own contents, so as to force them forward towards the heart.

APPENDIX.

APPENDIX.

No. I.

M. Legallois's Report of the Experiments on the Venous Circulation, made at the Faculté de Médecine.

EXPERIENCES FAITES A LA FACULTE DE MEDECINE PAR M LE Dr. BARRY.

N. B. Les rapports indiqués supposent l'animal debout, dans une position naturelle.

Première Expérience.

Le 14 Juin, en présence de MM. Laennec professeur à la Faculté, Breschet, chef des travaux anatomiques, Billery de Grenoble, Bennet, chirurgien du Collège de Londres, et de plusieurs élèves, M. Barry a répété l'expérience suivante, déjà consignée dans le mémoire qu'il a eu l'honneur de lire à l'Académie des Sciences dans la séance du 8 de ce mois.

La jugulaire interne fut mise à découvert sur un chien de petite taille. Une incision ayant été pratiquée aux parois de cette veine, une sonde de gomme élastique fut introduite dans sa cavité, et dirigée vers le cœur. Au bout

extérieur de cette sonde était fixé un robinet, dans l'autre extrémité duquel on introduisit un tube de verre coudé à angle droit et en partie contourné en spirale.

L'appareil ainsi disposé, le tube de verre fut mis en communication avec un vase rempli d'une teinture d'indigo; puis le robinet ayant été ouvert, on vit qu'à chaque dilatation inspiratoire du thorax, le liquide bleu passait dans le cavité du tube, et s'y élevait à une hauteur d'autant plus considérable que l'inspiration était plus prononcée. Dans l'expiration, le liquide restait en place, ou rétrogradait un peu vers le vase. A la fin de l'expérience seulement, le sang veineux refluait quelquefois vers le tube lorsque l'animal expirait.

Deuxième Expérience.

La même expérience fut répété sur un cheval, le 10 Juin, devant MM. Laennec, Cruveilhier, professeur d'anatomie à l'Ecole de Médecine; Breschet, Bogros, prosecteur de la même faculté; Bennet, et de beaucoup d'élèves. Les résultats furent les mêmes, à cette différence près, que pendant l'expiration on n'observa aucune régurgitation du sang veineux dans le tube. Pendant l'inspiration, le liquide affluait en abondance vers le cœur, et bientôt il ne'en resta plus dans le vase, qu'on fut obligé de remplir une seconde fois.

Ces préparatifs terminés, il devint facile d'établir par l'intermédiaire de la sonde une communication entre la cavité du péricarde et un vase rempli d'une liqueur colorée en bleu. Alors il fut sensible pour tous les yeux qu'à chaque mouvement d'inspiration la liqueur s'élevait dans le tube, qu'elle redescendait dans l'expiration, et que ces mouvemens étaient pour la vitesse et pour l'étendue précisément en raison directe de ceux du thorax; de telle sorte que quand la respiration était profonde, le liquide s'élevait très-haut, et

pénétrait même dans le péricarde, tandis qu'il semblait agité d'oscillations courtes et rapides quand les mouvemens de la poitrine étaient faibles, mais rapproches*.

Signé : Eug. Legallois.
Aide de clinique à la Charité.

* Le procès-verbal de ces expériences fut redigé sous les yeux de M. le professeur Laennec, par son élève, M. Legallois, jeune, homme de talent, et fils du célèbre physiologiste de ce nom.

No. II.

Letter addressed to Dr. Barry *by* M. Girard, *Director of the Veterinary School at Alfort.*

Alfort, ce 6 *Juillet*, 1825.

(Ministère de l'Interieur.)

Monsieur le Docteur.

J'ai l'honneur de vous annoncer que j'ai pris des mesures pour que plusieurs chevaux soient soumis à vos expériences vendredi prochain. Si vos occupations vous permettent de vous rendre à l'école ce jour la, je serai flatté de vous recevoir, et de vous donner toutes les facilités que vous pourrez désirer.

Agréez, Monsieur le Docteur, l'assurance de la considération distinguée avec laquelle j'ai l'honneur d'être

Votre très-humble et très-obéissant Serviteur,
le Directeur de l'Ecole,
Girard.

M. Le Docteur Barry, rue de la Paix, No. 12, *bis.*

No. III.

Report made to the Institute of France by Baron Cuvier *and Professor* Dumeril, *upon the Memoir on the Venous Circulation.*

INSTITUT DE FRANCE.

ACADEMIE ROYALE DES SCIENCES.

Le Secrétaire Perpétuel de l'Académie pour les Sciences Naturelles certifie que ce qui suit est extrait du procès-verbal de la séance du lundi 29 Août 1825.

La circulation dans les animaux à vertèbres est l'une des parties de la physiologie sur laquelle nous avons acquis le plus de connaissances positives. Ces notions exactes ne datent cependant que du commencement du xvi[e] siècle, époque à laquelle Harvey démontra le véritable mécanisme, qui met en mouvement et qui favorise le transport continuel du sang. On sait que les canaux qui partent du cœur, et par lesquels le sang est poussé, dirigé vers toutes les parties du corps, sont les *artères ;* et que ceux qui conduisent le sang, le chyle ou la lymphe au cœur, ont reçu le nom de *veines ;* enfin que le cœur, ou l'organe qui détermine jusqu'à un certain point, le mode de circulation, varie par sa position, par sa structure, suivant beaucoup de circonstances qu'on est parvenu à apprécier, quoique le véritable mécanisme par lequel son action s'exécute reste à peu près le même.

La direction suivant laquelle le sang veineux est constamment entraîné vers le cœur avait été reconnue par Michel Servet plus de cinquante ans avant les expériences positives qui firent découvrir à Harvey le véritable mécanisme de la

circulation. Cependant, depuis cette importante et mémorable découverte, il s'est élevé un grand nombre de discussions sur les véritables causes de la progression du sang dans les veines.

Sans présenter ici une histoire chronologique des diverses opinions émises à ce sujet, il est important pour la question que nous allons avoir à examiner, de rapporter brièvement les principales. Nous mettons au premier rang l'action impulsive du cœur et des artères qui se continuerait par la pression qu'elle est censée exercer sur les radicules des veines, avec lesquelles les artères s'abouchent dans leur transmission. Telle était l'idée de Harvey. Suivant Bichat, la puissance absorbante du système capillaire veineux suffirait pour faire commencer d'abord, et continuer ensuite, cette progression à l'aide de l'action des parois des veines elles-mêmes. Enfin, suivant l'opinion de divers auteurs, un grand nombre de causes accessoires faciliteraient cette action des veines; telles sont: le mouvement des gros troncs artériels, placés le plus souvent entre deux veines, la pression exercée à l'extérieur et au-dedans de tous les organes, par la peau, par les muscles, par les viscères qui s'affaissent alternativement après avoir été distendus. Mais c'est surtout l'action de la respiration dont la coïncidence a été observée d'une manière très-évidente, comme corréspondante au retour mécanique du sang par les veines. Pour expliquer cet effet, les uns ont supposé que le sang était appelé avec d'autant plus de vitesse, que les poumons étaient plus vides (Rudiger), ou qu'une inspiration plus forte et plus rapide permettait au sang un cours plus libre dans les poumons (Santorini). Haller (tome 2 de sa *Physiologie*, page 333) cite un grand nombre d'expériences qu'il a répétées sur les animaux vivans, d'après celles de Valsalva et de Morgagni, par lesquelles il a reconnu qu'en mettant à nu

les grosses veines, telles que les caves supérieures et inférieures, les jugulaires, les sous-clavières, c'était au moment où l'animal faisait une forte inspiration que le sang veineux parvenait au cœur; que, dans cet instant, toutes ces veines se désemplissaient, pâlissaient et s'aplatissaient, se vidaient du sang qu'elles contenaient; que, dans l'expiration qui suivait immédiatement, les mêmes veines se gonflaient, devenaient bleues, cylindriques; et que, plus les deux temps de la respiration étaient marqués, plus ces phénomènes devenaient apparens.

Morgagni avait même dit (de *Causis et Sedibus Morborum*, lib. 19, art. 33 et 34), qu'en considérant attentivement la veine jugulaire mise à découvert sur un chien vivant, et en appuyant la main sur l'abdomen de l'animal, il avait évidemment reconnu que, toutes les fois que, par l'acte de l'inspiration, le ventre s'élevait, dans le même moment la veine s'affaissait pour se regonfler aussitôt que, par l'acte de l'expiration, les parois de l'abdomen retombaient sur elles-mêmes.

Depuis, un grand nombre d'auteurs, en particulier notre habile confrère M. Magendie (*Physiologie*, 2nde édition, page 418), ont vérifié ces circonstances, et ont apporté en preuve de cette concordance de l'inspiration avec l'accélération du mouvement dans les gros troncs veineux, des expériences nouvelles et ingénieuses qui ont confirmé la réalité constante de ce phénomène, mais en la regardant comme un moyen accessoire qui facilite l'abord du sang veineux.

Enfin, quoique la plupart des physiologistes aient attribué uniquement au vide qui s'opère dans le cœur la progression du sang veineux dans cet organe, Bichat (*Anatomie générale*, tome i., page 429) a dit avec raison que ce mouvement éprouvé par le sang dans les veines exigeait encore beaucoup de recherches; car, ajoute-t-il, malgré tout ce qu'ont

écrit les auteurs sur cette question, elle offre une obscurité où on n'entrevoit encore que quelques traits de lumière.

Nous avons cru devoir entrer dans ces détails pour mettre l'Académie dans le cas de juger le mémoire pour l'examen duquel M. le Baron Cuvier et moi avons l'honneur d'être désignés commissaires.

Dans ce travail, M. le docteur Barry expose ses idées particulières sur le mouvement du sang dans les veines; il décrit avec beaucoup de détails les procédés qu'il a imaginés, nous pouvons le dire, avec sagacité; qu'il a exécutés très-adroitement sur les animaux, et qu'il a répétés avec la plus grande complaisance et à plusieurs reprises sous les yeux de vos commissaires.

Son mémoire présente trois objets de recherches principaux.

1. De déterminer par des expériences positives quelle est la puissance qui force le sang veineux de se diriger des plus petites ramifications où il est puisé jusqu'au cœur, où il aboutit.

2. D'apprécier et de comparer la vitesse avec laquelle le sang se meut dans les veines et dans les artères.

3. D'établir que l'abord continuel du sang veineux ne peut être assigne *uniquement* aux causes auxquelles il a été attribué jusqu'à présent.

Sous le premier point de vue, en étudiant le phénomène de la circulation veineuse, M. Barry a été conduit à reconnaître que, par l'acte de l'inspiration, il se fait un vide dans la cavité de la poitrine, laquelle tend à se dilater, et que tout le liquide en communication avec l'intérieur du thorax devait y être attiré comme forcé par la pression atmosphérique. Tous les faits connus trouvent, il faut l'avouer, leur explication dans cet effet physique; tels sont en particulier le gonflement des veines jugulaires dans l'expiration, et leur

affaissement dans le mouvement inverse; la cessation de certaines hémorrhagies par des inspirations forcées; l'absorption de l'air par les veines et les accidens qui en ont été la suite lors de l'ouverture ou de la section de quelques-uns de ces grands canaux voisins du cœur.

L'auteur ne s'est pas contenté de rapprocher ces faits, qui viennent à l'appui de son opinion, il a voulu la corroborer par des expériences directes, dont voici les principales.

Ayant ajusté sur l'une des grosses veines, comme sur la jugulaire d'un animal vivant, le bout d'un tube de verre garni d'un robinet, et ayant placé l'autre extrémité libre de ce tube dans une liqueur colorée, il a reconnu, après avoir ouvert le robinet, que, toutes les fois que l'animal faisait une forte inspiration, le liquide était vivement absorbé, et que dans l'expiration, au contraire, il restait stationnaire, s'il ne refluait pas.

Nous pouvons annoncer de suite que le même phénomène se reproduisait toutes les fois que l'expérimentateur avait introduit le même tube disposé très-artistement dans un des cavités du thorax, et même du péricarde.

Afin de rendre ce mouvement du liquide absorbé par le tube plus sensible à la vue, M. Barry s'est servi de canaux contournés en spirale, afin que, l'espace à parcourir étant plus long, le mouvement devînt plus evident; et, pour rendre leur ascension plus distincte, il a mêlé ou introduit dans les liquides colorés quelques gouttes d'huile ou des bulles d'air, qui servaient à faire mieux distinguer leur progression.

Dans toutes ces expériences, exécutées avec la plus grande adresse et avec des précautions bien satisfaisantes contre toutes les objections qu'on pourrait leur opposer, l'auteur du mémoire, dont nous désirons faire connaître les conséquences, s'est assuré que le mouvement aspirateur de la grosse veine

était coïncident avec l'instant où l'animal tendait à opérer le vide dans la poitrine ; que le sang noir ne traverse les veines que pendant l'acte et le temps de l'inspiration, et que ce mouvement veineux est toujours placé sous l'influence de l'action et de la pression atmosphérique.

M. Barry est tellement convaincu de cette action de l'atmosphère sur l'absorption veineuse, qu'il regarde comme un moyen assuré d'empêcher l'absorption d'une matière vénéneuse, l'application d'une ventouse sur une plaie récemment empoisonnée, ou dans l'intérieur de laquelle on aurait introduit une substance délétère.

M. le docteur Barry attribue également à la pression atmosphérique l'action absorbante du système pulmonaire vénoso-artériel, ou de la petite circulation. Mais ici l'auteur offre plutôt des raisonnemens établis sur des dispositions anatomiques que sur des observations positives, et quelques faits d'anatomie comparée pourraient être objectés avec succès à cette opinion, que l'auteur n'a pas présentée avec des expériences aussi concluantes que celles dont il s'est appuyé pour démontrer l'action de la pression de l'atmosphère sur la grande circulation veineuse.

Quant à l'appréciation de la vitesse comparée du sang dans les deux ordres de vaisseaux qu'il parcourt, l'auteur l'a faite d'après l'idée que la pression de l'atmosphère est la principale puissance qui pousse le sang veineux dans le cœur pendant l'inspiration. Ce sang doit nécessairement se mouvoir avec une rapidité qui est à celle du sang artériel comme le temps employé à une respiration entière est à celui d'une seule et unique inspiration, et que la fréquence du pouls ne peut être prise comme la mesure de la vélocité du sang qui revient au cœur, puisque, dans la première hypothèse, ce serait la répétition du mouvement inspirateur qui réglerait cette vélocité. Cette partie du mémoire est

entièrement fondée sur le raisonnement, et n'est pas appuyée de preuves et d'observations qui nous permettent de manifester une opinion sur ce sujet.

Enfin, quant à la dernière conséquence que l'auteur paraît devoir tirer de son mémoire, que l'abord du sang veineux au cœur ne peut être uniquement attribué aux causes indiquées jusqu'à présent, nous avouerons que cette idée de la pression de l'atmosphère comme cause principale n'a pas été primitivement reconnue par lui ; plusieurs autres l'avaient indiqué, même avant le docteur Zugenbuhler, qui a cru devoir faire une réclamation à l'académie, en lui envoyant une dissertation *de Motu Sanguinis per Venas*, publiée en 1815.

Mais l'auteur, tout en reconnaissant l'action très-évidente de la pression de l'atmosphère, regarde le cœur comme la cause première du vide qui s'opère dans le système, tandis que M. Barry attribue la dilatation du cœur lui-même et de ses oreillettes à la tendance au vide qui s'opère dans toute la cavité de la poitrine dans l'acte de l'inspiration, en démontrant cette action par des expériences positives, tandis que M. Zugenbuhler ne présente que des raisonnemens à l'appui de son opinion.

En terminant ce rapport sur le mémoire intéressant de M. Barry, dans lequel nous nous faisons un devoir de déclarer que les expériences décrites avec beaucoup de détails par l'auteur ont été faites et répétées plus de vingt fois sur des chiens, sur des brebis, sur des chevaux ; qu'elles ont constamment réussi toutes les fois qu'il a pu exécuter, comme il le désirait, les procédés ingénieux qu'il a imaginés dans ce but, et que ces recherches expérimentales ont eu lieu sous nos yeux à la Faculté e Médecine, au Jardin du Roi, à l'Ecole d'Alfort, devant M. Girard, et aux abattoirs de Mont-faucon.

Vos commissaires jugent ces recherches faites dans un très-bon esprit et très-propres à éclairer l'histoire physiologique de la circulation veineuse dans les mammifères. Sous ce rapport, ils ont l'honneur de proposer à l'Académie d'inviter l'auteur à poursuivre ses recherches sur les causes de l'absorption, recherches qui peuvent offrir un grand intérêt et des applications très-utiles à l'économie animale ; de décider que le mémoire de M. Barry sera inséré parmi ceux des savans étrangers. Cependant ils ne doivent pas laisser ignorer que, dans leur opinion particulière, l'acte de l'inspiration qui peut produire le vide, et par suite l'appel du sang veineux dans la cavité du thorax chez les animaux à poumons, tels que les mammifères et les oiseaux, ne suffit pas pour expliquer le mouvement du sang dans les veines chez quelques reptiles et chez les poissons, qui ont un autre mode de réspiration, la même coïncidence d'action ne pouvant se trouver entre l'inspiration qui s'opère chez ces animaux par une véritable déglutition et l'abord du sang veineux dans la cavité de leur cœur.

(Signé.) Le Baron CUVIER.
DUMERIL, Rapporteur.

L'Académie adopte les conclusions du rapport.

Certifié conforme.

Le Secrétaire perpétuel, Conseiller-d'Etat, Commandeur de l'ordre royal de la Légion-d'Honneur.

(Signé) Baron CUVIER.

No. IV.

Extract from the Report presented to the Académie de Médecine, by Professor Laennec, upon the Experiments connected with External Absorption and Traumatic Poisoning.

" L'Académie nous a chargé, Messieurs Adelon, Orfila et Moi, de lui rendre compte d'expériences faites par M. Le Dr. Barry qui lui ont été communiquées par l'auteur dans l'une de ses dernières séances, et qui tendent à prouver, que la pression atmosphérique est la principale cause de l'absorption lymphatique et veineuse. Ces expériences consistent en ce qui suit, &c.

Vos Commissaires pensent en conséquence,

" 1°. Que les expériences de M. Le Dr. Barry, qui sont une suite de celles par lesquelles il a déjà cherché à démontrer que la circulation veineuse se fait principalement, sous l'influence de la pression atmosphérique, établissent d'une manière incontestable cette influence pour la circulation dans les vaisseaux absorbans ; ce que l'auteur se proposoit de démontrer.

" 2°. Que la connaissance de ce fait important peut être regardée comme *une véritable découverte*, non obstant les apperçues et les idées vagues émises par quelques auteurs sur l'attraction du sang vers le cœur, et la pratique empirique de la succion dans les plaies empoisonnées, plus usitée chez les peuples à demi-civilisées que chez les nations polies.

" 3°. Vos Commissaires vous proposent d'addresser des remerciemens à M. Le Dr. Barry, de l'engager à répéter

ses expériences sur le virus de la vipère, d'insérer son mémoire parmi ceux de l'académie, et de mettre son nom sur la liste des candidats aux places d'associés étrangers de l'académie.

(Signé.) M. Laennec, D.M.

LONDON:
PRINTED BY WILLIAM CLOWES,
Northumberland-court.

Chevallier

Aug. 18. 65.